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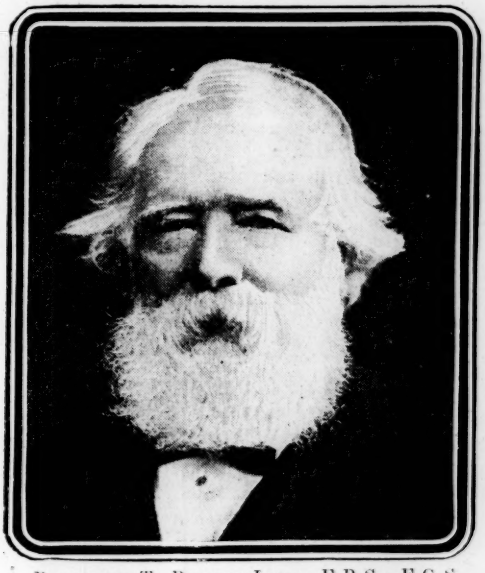
ORIGINAL ARTICLES.

I.—Rev. Osmond Fisher, M.A., F.G.S.[1] (November 17, 1817).

Professor T. Rupert Jones, F.R.S., F.G.S.[2] (October 1, 1819).

WE offer warmest congratulations to two dear and valued friends connected with the Geological Magazine since its commencement, both having been constant contributors, and Professor Rupert Jones in addition one of the Editors during the first year of the journal's existence.



Professor T. Rupert Jones, F.R.S., F.G.S.
From a photograph by Maull & Fox (ex "Graphic", October 5, 1907).

If living illustrations were needed of the value of geology as a health-giving pursuit, the two eminent men here cited—one 92, the other

[1] For life and portrait of Rev. O. Fisher, see Geol. Mag., 1900, pp. 49–54.
[2] For life and portrait of Professor T. Rupert Jones, see Geol. Mag., 1893, pp. 1–3.

90 years of age—both in the enjoyment of good health, and still interested in their favourite studies, would afford the strongest recommendation to all, not already enrolled, to join at once the noble brotherhood of the hammer.

It is hoped that this note may convey to these fathers of science in their peaceful retirement not only our own earnest good wishes, but those of many other of their geological friends and admirers.

II.—Notes on Fossil Plants from the Witteberg Series of Cape Colony.

By A. C. Seward, F.R.S., Cambridge.

(PLATE XXVIII.)

THE specimens described below were sent to me for examination by Professor Schwarz from the Albany Museum, Grahamstown; they were collected from a thin seam of shale in the Grahamstown district in the Witteberg Series. This series, so named from the Wittebergen in the south of the Karroo, consists of a group of shales, sandstones, and quartzites, which are placed at the summit of the Cape Series below the plant-bearing and glacial beds of the Lower Karroo system. The Witteberg Series have afforded a very few fossils; these include imperfectly preserved fragments of Lepidodendroid plants and an abundance of the fossil known as *Spirophyton*, referred by some authors to the vegetable kingdom and by others regarded as probably inorganic.[1]

In a paper published in the Records of the Albany Museum, Professor Schwarz[2] has described the following new species based on material which does not admit of satisfactory diagnosis: *Lepidodendron albanense*, *L. kowiense*, *Bothrodendron irregulare*, *B. cæspitosum*, *Didymophyllum* (*Stigmaria*) *expansum*. So far as it is possible to base an opinion on his published drawings, I am disposed to regard the specimens as possibly referable to a single type. The fossils sent to me are larger and apparently in a better state of preservation than those described by Schwarz.

Bothrodendron irregulare, Schwarz. Pl. XXVIII, Figs. 1–4.

Under this name Mr. Schwarz has described "a common species occurring in the quartzites and intercalated shales of the Witteberg Series at Port Alfred, near Grahamstown".[3] As the small specimen which he figures as the type of *Bothrodendron irregulare* is no doubt identical with some at least of those described below, I have adopted his designation. The fossils which I refer to *Bothrodendron irregulare* include two fairly distinct forms: (1) impressions and casts of small branches characterized by crowded scars or tubercles and showing in a few cases portions of acicular leaves; (2) larger branches characterized

[1] Seward, Annals S. African Museum, 1903, vol. iv, p. 103.
[2] Records of the Albany Museum, 1906, vol. i, p. 347.
[3] Schwarz, loc. cit., p. 356, pl. vi, fig. 4.

by oval or circular depressions, or, in the casts, by rather broad truncated ridges. These two forms, shown in Figs. 1–4, I regard as specifically identical, a conclusion which receives support from an examination of the much richer material described by Nathorst from the Devonian of Bear Island.[1]

Fig. 4. This is a good example of the smaller form of branch in which the axis, 1·2 cm. wide, is dichotomously branched, and the surface bears numerous small oval or circular scars. This specimen is probably identical with one previously figured[2] from the Port Alfred range, and now in the British Museum collection, and with some of the specimens figured by Schwarz. A similar form has been figured by Nathorst as *Bothrodendron Carneggianum* (Heer)[3] from Bear Island, and some of the examples of *B. brevifolium* and *B. kiltorkense*,[4] described by the same author, bear a striking resemblance to the African fossils.

The material hardly justifies a decided opinion as to the specific identity of the northern and southern plants, but it is at least clear that they represent closely allied types.

The specimen represented in Fig. 3 shows more clearly the small scars which are disposed spirally and in horizontal rows. The horizontal arrangement is a conspicuous feature of several of the Bear Island examples of *Bothrodendron*. Several acicular leaves are seen on the left-hand side of this specimen The larger form is illustrated by the specimens shown in Figs. 1 and 2.

In the example shown in Fig. 2 the upper surface bears slightly raised ridges terminating in scars. On the lower surface, that is the impression of the cast, the scars are clearly seen as depressions. The smaller specimen shown in Fig. 1 suggests at first sight a comparison with *Sigillaria* owing to the prominence of the rounded ribs. There is a close resemblance between this specimen and some of those figured by Nathorst as *Bothrodendron kiltorkense* in the *Knorria* condition from Bear Island. Some of the casts are those of branches in a partially decorticated condition; the scars are not the actual leaf-scars as they appeared on the surface of the living plant, but casts of gaps in the more external cortex. These gaps were formed by the decay of a sheath of delicate tissue which surrounded each leaf-trace as it passed through the cortex of the branch on its way to a leaf. The uneven surface of the scars as seen in Fig. 1 is the result of fracture of the slender argillaceous casts of the leaf-trace gaps.

None of the specimens examined retain the original surface characters; all are more or less decorticated. It is therefore impossible to say whether the surface of the branches exhibited the fine sculpturing characteristic of *Bothrodendron* or the delicate reticulum which distinguishes Weiss's genus *Pinakodendron*.[5] None of the

[1] Nathorst, *Kongl. Svenska Vetenskaps-Akad. Handl.*, 1894, Bd. xxvi, No. 4; ibid., 1902, Bd. xxxvi, No. 3.

[2] Seward, loc. cit., p. 89, fig. 8.

[3] *Kongl. Vetenskaps-Akad. Handl.*, Bd. xxvi, pl. xiv, fig. 10.

[4] Ibid., Bd. xxxvi, pls. xi, xii.

[5] Kidston, Trans. R. Soc. Edinburgh, 1903, vol. xl, pt. iv, p. 797, pl. i, figs. 9–11.

actual leaf-scars are preserved with the surface-features intact, and it is therefore not possible to describe the position of the leaf-trace scars or the parichnos. Some of the smaller branches have probably lost less of the cortical tissues than the larger impressions, which represent the *Knorria* form of the species. In spite of the imperfection of the material there cannot be any serious doubt as to the generic nature of the specimens.

It is impossible to say whether *Bothrodendron irregulare* is identical with *B. kiltorkense* or with other previously described species, but the additional specimens from the Albany Museum are interesting from the point of view of the wide geographical distribution of this generic type in Lower Carboniferous or Devonian strata. An Australian specimen described by Feistmantel as *Cyclostigma* sp.[1] may be compared with *B. irregulare*, and the species *C. hercynianum*, figured by Weiss and by Potonié from Devonian rocks of the Hartz,[2] is another example of a closely allied or even identical type of stem. The species *B. Leslii*[3] from the Lower Karroo sandstones of Vereeniging may also be compared with the Witteberg species.

Hastimima sp. Pl. XXVIII, Figs. 5, 6.

In an account of the fossil flora of the Coal-measures of Brazil, recently published by Dr. David White,[4] some problematical fossils are described from a plant-bed north-east of Minas, Santa Catharina, under a new generic name *Hastimima*. Some at least of the specimens referred to *Hastimima Whitei* exhibit a close resemblance to the fossil from Cape Colony shown in Figs. 5 and 6, which I propose to designate *Hastimima* sp., without being able to adduce any conclusive evidence as to the nature of the genus.

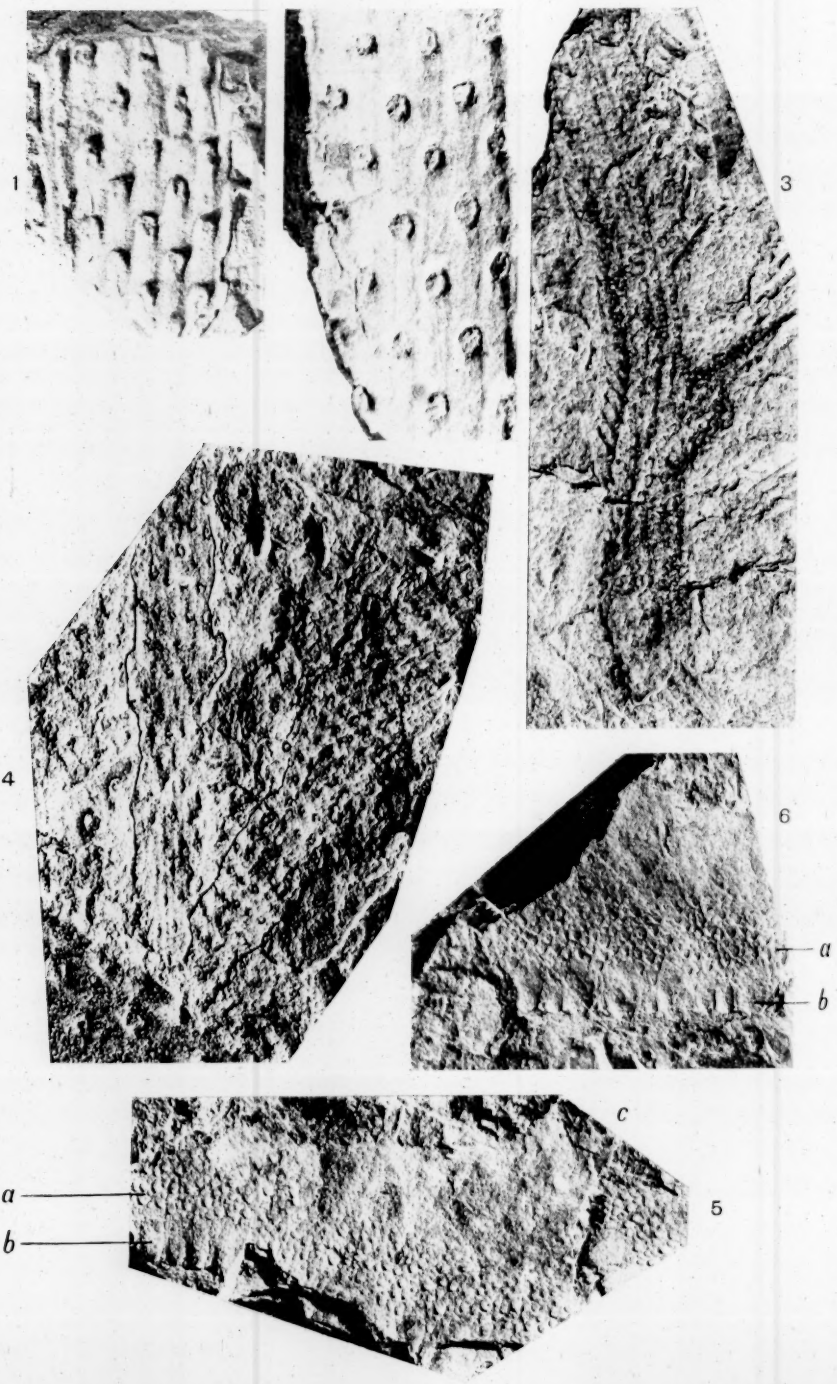
The specimen represented in Figs. 5, 6 consists of a flat surface with an ill-defined boundary on the left-hand side, and prolonged at the top in Fig. 5, *c*, *a*, for a short distance as a narrow branch. Towards the upper margin the surface of the impression presents on slight magnification a fine scaly appearance, and this becomes gradually more obvious towards the lower edge; the scaly appearance is caused by numerous slightly projecting elevations terminated distally by a free rounded edge. These scale-like projections are not distributed with any regularity, and in none of them can I detect any indication of a pit such as would be formed by a vascular bundle. At the lower edge, where the impression is more complete, the scales are succeeded rather suddenly by a row of larger rounded ridges (Fig. 5, *b*), beyond and slightly below which is a narrow strip of shale showing discontinuous vertical ridges and small tubercles. The larger ridges are shown also in Fig. 6, *b*, which represents the reverse of the specimen shown on Fig. 5. In this view the scale-like

[1] Feistmantel, Mem. Geol. Survey, New South Wales, Palæontology, No. 3, 1890, pl. ii, fig. 7.

[2] Weiss, *Jahrb. k. preuss. geolog. Landesanstalt*, 1885, p. 175, pl. vii; Potonié, *Abh. k. preuss. geol. Land.* (Neue Folge), 1901, Heft xxxvi, p. 32.

[3] Seward, Ann. S. African Museum, 1903, vol. iv, p. 87, pl. xi.

[4] Commissão dos Estudos das Minas de Carvão de Pedra do Brasil. Final report by I. C. White, Rio de Janeiro, 1908, p. 589, pls. x, xi.



D. Elliott phot.

appearance is more clearly seen, but in the form of depressions. The depressions vary in size and exhibit no regularity of arrangement.

Dr. White expresses the opinion that he is strongly inclined to regard the fossils as not vegetable, but, he adds, if *Hastimima* is a plant, "it would seem that the tubercles [scales] should be interpreted as sporangia or sporangiferous, as cushions giving rise to some appendages, or as glands." With this suggested interpretation I am unable to agree. The idea occurred to Dr. White as to myself, before I read his description, that the tuberculate impression might belong to some animal, but "a number of eminent American specialists in vertebrate palæontology", to whom Dr. White showed the material, were unwilling to accept the fossils as coming within their province. The author of the genus expresses the opinion that it will probably be found later in other Lower Gondwana areas, a prophecy which appears to be now partly fulfilled. The Indian fossils described originally by Feistmantel,[1] and more recently by Zeiller,[2] as *Dictyopteris* are compared by White with his specimens, but I agree with him that the two are not generically identical.

At first sight the row of rounded ridges shown in Figs. 5, 6, *b*, reminded me of the strips of secondary wood separated by medullary rays which are seen in some longitudinally split examples of *Stigmaria* such as that figured by Williamson[3] in his monograph of the genus, but it would seem impossible to explain on this comparison the irregularly arranged smaller scales. *The view which seems to me most hopeful is that this fossil represents part of a body-segment of a Eurypterid.* A comparison of Figs. 5, 6 with several of the drawings given in Dr. Woodward's monograph of the British Fossil Crustaceans belonging to the order Merostomata[4] leads me to think that it is far from improbable that the impression has been produced by some Eurypterid. This comparison has, however, but little claim to be considered more than a guess, and we must wait for further discoveries to decide the nature of the Mexican and African specimens.

EXPLANATION OF PLATE XXVIII.

Figs. 1–4. *Bothrodendron irregulare*, Schwarz. (Nat. size.)
,, 5, 6. *Hastimima* sp. (Nat. size.)

P.S.—Since the above notes were written I have had the benefit of Dr. Woodward's opinion on the specimen represented in Figs. 5 and 6. This he has now stated in a "Note on the genus *Hastimima*"; his conclusions convert my 'guess' as to the Eurypterid nature of the fossil into an identification which is unlikely to be seriously questioned. Dr. Woodward, by his ready response to my request to examine the specimens, has contributed a valuable piece of evidence in regard to the geological age of the Witteberg Series of Cape Colony.

[1] Feistmantel, Mem. Geol. Surv. India, 1881, vol. iii, pl. xxiiiA, figs. 4–6, 14.
[2] Zeiller, ibid., 1902, vol. ii (New Series), p. 24, pl. iv, fig. 8.
[3] Palæontographical Society, 1887, pl. xiv, fig. 68.
[4] Ibid., 1866–78.

III.—Note on the genus *Hastimima* from Brazil and the Cape.

By Henry Woodward, LL.D., F.R.S.

Professor Seward has called my attention to Figs. 5 and 6 on Plate XXVIII, which accompanies his notes on Fossil Plants from Cape Colony. These fragmentary impressions of organic remains have been compared by him with similar doubtful plant-remains figured by Dr. David White from the Coal-measures of Brazil (see *Commissao dos Estudos das Minas de Carvão de Pedra do Brasil*, Estampa x and xi. Final Report by J. C. White, Rio de Janeiro, 1908, p. 589.) Dr. White had already doubted the vegetable nature of the specimens from Brazil, which doubt is shared by Professor Seward, but the latter expresses himself more definitely against the plant-nature of Figs. 5 and 6, Pl. XXVIII, from the Witteberg Series of Cape Colony. He has, in fact, suggested that they "represent part of a body-segment of a Eurypterid." In this opinion I cordially agree. I also wish to add a word about the specimens figured under the name of *Hastimima* by Dr. David White from the Coal-measures of Brazil.

In this Memoir, on pl. x, five figures are referred to as *Hastimima Whitei*, namely, figs. 1 and 2, which appear to represent, *probably*, the impression and counterpart of an imperfect thoracic segment of an Arthropod, the lateral and posterior margins of which are readily to be seen, and the latero-posterior angle which they form is slightly produced and falcate as shown in the body-segments of *Pterygotus anglicus*, drawn on pls. i and ii, fig. 1, of my monograph on the Merostomata (Pal. Soc. Mon., 1865). The usual scale-like markings, however, are only seen near the margins of fig. 1, and are represented enlarged four times in fig. 1*a* of Dr. White's plate. The rest of the segment is ornamented by a series of small, short, bluntly-rounded spines, sparsely distributed over the surface and pointing towards the posterior border. They are shown in relief in fig. 1 and as depressions on the surface in fig. 2 of pl. x. Figs. 3 and 4 on the same plate also represent the impression and counterpart of another portion, most probably of the same animal, as the scabrous surface-ornamentation is of the same kind, being in relievo on one half (fig. 3) and in intaglio on the other (fig. 4). This specimen, which is rather acutely hastate in form, may represent the 'telson' or tail-spine of a *Pterygotus*, the margins, as far as preserved, are bilaterally symmetrical, and there is a median ridge on fig. 3 and a corresponding depression on fig. 4. It is too regular and pointed to have been the spatulate extremity of one of the swimming-paddles, and cannot be a leaf, although no doubt at first supposed to be one. The scabrous ornamentation on these specimens agrees very closely with that of *Eurypterus punctatus*, Salter, sp., from the Lower Ludlow Beds, Church Hill, Leintwardine.[1] A similar ornamentation is observed on the segments of a large form referred to *Echinocaris Wrightiana*, Dawson, sp. (Jones & Woodward, Geol. Mag., 1884, p. 393, Pl. XIII, Figs. 1*a*, 1*b*. Woodcuts of

[1] For drawings of *E. punctatus*, Salter, sp., see H. Woodward's Monograph on the Merostomata, 1872, pt. iv, p. 153, fig. 51; p. 157, etc.

ornamentation, drawn by Professor Jas. Hall, are given (see A and B, op. cit., p. 395), from the Portage Group (Upper Erian), New York).

Turning now to pl. xi, also from the Coal-measures of Brazil, Dr. White gives on this plate ten figures, referred to *Hastimima Whitei*: these are mostly small fragments, and having been considered when drawn to be plants, they were nearly all figured with the posterior border upwards; the plate has, consequently, to be turned upside down in order to see the objects properly in their natural position. It is pretty certain that figs. 1–5, 7–9 on this plate (pl. xi) are referable to the same Arthropod as are figs. 1–4, pl. x, already noticed. Figs. 1 and 2 may be parts of appendages, but are very obscure: 2*a* shows distinct scale-markings, and traces of an obscure appendage, possibly part of a swimming-foot, like fig. 1. Fig. 3 shows impressions of obtuse spines on one part and scale-markings clearly visible on the other part.

The surface of fig. 4 is entirely covered with very minute elongate tubercles, like those seen on *Eurypterus punctatus*, Salter, sp.; fig. 5 is no doubt of the same nature as fig. 3, having impressions of obtuse spines on its surface; figs. 6–8 are small portions of the posterior borders of body-segments of *Eurypterus*, showing rounded (in fig. 6) or pointed (in figs. 7 and 8) marginal serrations, and the surface covered by scale-markings. The margin of fig. 9 resembles those in the specimen from the Witteberg Series of Cape Colony, figured on Professor Seward's plate (Pl. XXVIII, Figs. 5 and 6), in not being so deeply and strongly scalloped along the posterior border, but the surface is also scale-marked and has two spots indicative of two short bluntly-rounded spines. Fig. 10 is too obscure to define with accuracy, but may probably be of the same Eurypterid nature as the others.

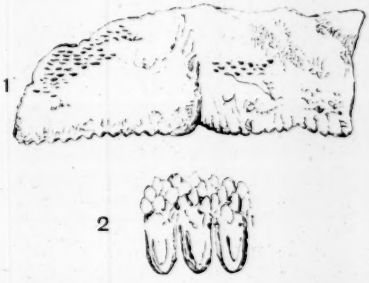


Fig. 1. Part of one of the body-segments of *Eurypterus hibernicus*, Baily.
,, 2. Part of the margin of same (enlarged) from the Devonian of Kiltorcan, Ireland.[1]

The Cape specimens—kindly sent to me to examine by Professor Seward—present, like the Brazil coal-shale specimens, clear evidence of being portions of segments of Eurypterids (see Pl. XXVIII, Figs. 5 and 6). The surface anteriorly is nearly smooth, that

[1] Reproduced from woodcut (Fig. 45) of *Eurypterus hibernicus*, Baily, from the Devonian rocks of Kiltorcan, Pal. Soc. Mon. Brit. Foss. Crustacea, Order *Merostomata*, by H. Woodward, 1872, pt. iv, p. 150.

portion having been overlapped by another and more anterior body-segment; this is succeeded by a band covered by scale-markings (*a*), about six rows deep, and next these follows the posterior crenulated border (*b*). (The specimens are numbered 2910 and 2911.) The first of these shows a piece of a body-segment, 75 mm. long by 40 mm. deep; only 20 mm. of the margin is preserved. There is a trace of another segment which underlies the above, also showing scale-markings and a small part of the scalloped margin. No. 2911 measures 60 mm. in length, by 40 in depth; 50 mm. of the posterior crenulated margin is preserved.

Like the remains of the Merostomata from British and Irish localities, those from Brazil and the Cape are also associated with plant-remains, and may have been of lacustrine origin. It is highly probable that, although based only upon fragmentary remains, *Hastimima* includes specimens of more than one species, if not of more than one genus. It is not my intention, however, to suggest fresh names for these fragmentary Arthropods; but their presence in such widely separated localities is a matter of extreme interest, and may prove useful as a means of marking synchronous or homotaxial horizons over very large areas. Similar fragments (see woodcut, Fig. 1) were observed by the late Mr. W. H. Baily in the Devonian rocks of Kiltorcan, as well as those already referred to in the Upper Ludlow of Shropshire.

IV.—Note on the Langkofl Thrust-mass.

By Mrs. Maria M. Ogilvie Gordon, D.Sc., Ph.D., F.L.S.

It will be remembered that two years ago, in 1907, I pointed out the occurrence of important planes of overthrust at the base of the Dolomite Mountain-massive of Langkofl and Plattkofl in South Tyrol, which explained its apparent 'reef-like' form, and its curious position above Wengen lavas in some places and Muschelkalk at others. I showed that at Langkofl the Upper Werfen Strata and Muschelkalk form a shear-slice above which the Schlern Dolomite rocks of the Langkofl Mountain have been overthrust, and below which the Wengen lavas and tuffs of the Ciampinoi meadowland are present; also that the planes above and below this shear-slice are crush-planes of extremely low inclination.

Last autumn I continued my researches in this district, but unfortunately, owing to the pressure of other business, it is only now that I have had an opportunity of preparing my work for publication.

In mapping the Ciampinoi and Wolkenstein hill area that descends from Langkofl to Gröden Valley, I traced an important thrust-plane northward across the Gröden Valley to the Sorasass Alpe and Pitsch-Berg on the north side. Disturbed strata are present in the Ciampinoi and Wolkenstein hill area, belonging to the Wengen, Buchenstein, Muschelkalk, and Werfen horizons, and they continue the same E.N.E.–W.S.W. strike as the thrust-band below the Langkofl. They are overthrust above the Wengen lavas and tuffs of the valley segment. Where the fault-plane is exposed on the western slope of the Ciampinoi hill it strikes N. 10 E. and dips *ca.* 20 E.,

but the surface is waved and bent, and the outcrop of the plane is frequently interrupted by small cross-faults. The plane is essentially a crush-plane, at which the older group of rocks has been thrust westward.

On the north side of the Gröden Valley the thrust-plane continues through the Pitsch-Berg, where the Werfen or Lower Triassic Strata have been overthrust westward above the Middle Trias. Further north rise the Dolomite peaks of the Geissler group, whose geological relations and 'reef-like' form Mojsisovics compared closely with those of the Langkofl Massive (*Dolomit-Riffe*, 1879, pp. 210–11). The band of Muschelkalk Rock at the base of the Dolomite in both these Massives reaches the height of 2200 met. contour, whereas in the Triassic succession of the Gröden Valley below St. Christina it is exposed at the 1400–1500 met. contours. The explanation, however, is provided in this important overthrust of the rocks of the Upper Gröden area, and the subsequent flexures and faults which the thrust-mass has undergone.

Near St. Christina, I detected in three of the stream-cuttings on the south side of Gröden Valley the same thrust-plane, almost horizontal, passing through the Wengen lavas and tuffs, and duplicating that horizon and the Buchenstein Strata; and I traced it westward where it underlies the Seiser Alpe. Thus the Langkofl or Schlern Dolomite thrust-mass simply rests upon another thrust-mass on the west. At a still lower level another thrust-plane is present, passing through the Buchenstein and Mendola Dolomite horizons, and with overthrust again of Augite, Porphyrite, and Buchenstein rocks.

The Upper Gröden thrust-mass is therefore composed of subjacent thrust-slices of varying thickness and importance. The thin shear-slice of portions of Werfen, Muschelkalk, Buchenstein, Porphyrite, and Wengen tuffs emerging from below Langkofl on the north side owes its position to an east-west dislocation within the thrust-mass. The thrust-planes below and above it are apparently the same as those above and below the lower segment of Schlern Dolomite and Wengen-Cassian Strata in Sella Massive. This thin shear-slice underlies the thick development of Schlern Dolomite in both Massives, which represents the main thrust-segment. In the Sella Massive it is succeeded by another thrust-slice at the Boe summit, where Raibl and Dachstein horizons have been overthrust above Upper Trias and fragments of Jurassic and Cretaceous Strata. The conformable succession of Schlern Dolomite upon Upper Cassian horizons belonging to the thrust-mass is well preserved on the southern and eastern flanks of the Langkofl Massive.

The similarity of the geological relations in the Langkofl and Sella Massives proves the essential continuity of the important thrust-plane at the base of the Schlern Dolomite. The varying dip of the plane to north or south or in other directions, both in Sella and Langkofl, is due to superimposed plicational and dislocational effects; while the position of the overthrust Cassian Strata and Schlern Dolomite relatively to different stratigraphical horizons in the underlying shear-slice indicates the previous existence of folds in the rock-masses cut

by the thrust-plane. The observations at Langkofl confirm the results I obtained for the district generally that the earliest folds had an east–west strike, while the overthrusts took place during a more advanced period of strong cross-compression.

At Langkofl the complex of thrust-slices has been segmented by several north–south 'step' faults of slight throw, the effect of which has been to lower the segments on the east side towards the north–south fault in Sella Pass with upthrow on the east. In former papers I have shown that this is also the case in Sella Massive, and has shattered the eastern aspect of that mountain as compared with the western; and that it also holds good for the Enneberg and Sett Sass area where the step faults lower the Valparola exposures of Raibl and Dachstein Strata on the east of Sett Sass. The dolomitic rock in these mountain-massives and in the Ampezzo and Gader Thal district is part of the same thrust-mass as Sella and Langkofl.

The Wengen Strata of the underlying or St. Christina and Seiser Alpe thrust-mass may be traced continuously from the north of Langkofl round the west of Plattkofl to the Duron Valley slopes on the south of the Dolomite Massive. There the thrust-mass of Langkofl and Sella Massive is downthrown, and the underlying mass upraised, on the north and south respectively of that leading east–west fault which I called the Rodella-Buchenstein fault.

The thrust-planes in the group of Lower and Middle Trias reappear in the south or Duron Valley slopes, and have the same effect as at St. Christina of duplicating or cutting out various horizons. The chief thrust-plane of the Duron Valley slopes occurs at 1700–1800 met. contour and continues as a well-marked plane of overthrust throughout the Mt. Donna and Bufaure Mountains. Above it are sheared slices of Werfen, Muschelkalk, Buchenstein Strata, and the Wengen lavas and tuffs; below it is a succession of Lower and Middle Trias which exhibits the petrographical and palæontological characteristics of the so-called northern and southern, or 'Rand' facies of the Dolomites, i.e. with well-defined Upper Werfen fossiliferous zones and the Middle Trias developed for the most part as a homogeneous calcareous or calcareo-dolomitic mass. According to my mapping of the thrust-planes in Fassa this calcareous facies exposed in the Vallaccia, Costabella, Marmolata, and other Massives represents the basal mass above which the thrust-slices with the porphyritic, tufaceous, and dolomitic facies have been driven.

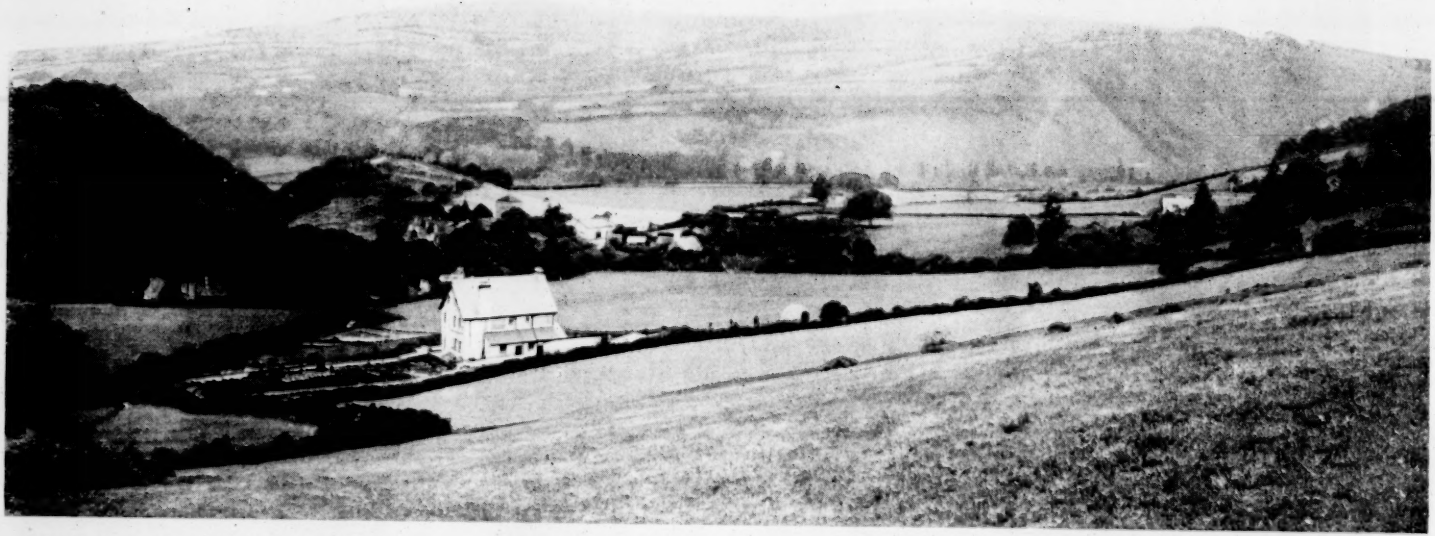
Subsequent folds and faults have lowered the rocks of the overthrust slices in some places between portions of the basal mass, so that in the Fassa and Contrin region the one facies suddenly gives place to the other and the complication of detail is very great.

V.—Some Glacial Features at Aberedw in the Wye Valley, near Builth Wells.

By L. Richardson, F.R.S.E., F.G.S.

(PLATE XXIX.)

WHILE pioneering for an excursion of the Cotteswold Naturalists' Field Club at Aberedw in the Wye Valley, between Builth Wells and Hay, certain very interesting physiographic features,



Phot. P. B. Abery, Builth Wells.

View of the mouth of the Aberedw Valley and its junction with that of the Wye. From left to right the features are: the wooded hill-side (Aberedw Rocks); post-Glacial gorge of the Edw; the bailey-castle-crowned tump; the level ground formed by the morainic matter filling up the pre-Glacial channel of the Edw; and the slope of the hill-side. The Wye enters the view by the valley on the right and leaves it by that on the left, the hills in the background being on the right (west) bank of the Wye.

obviously connected with Glacial action, were observed which appear worthy of record.

Aberedw is situated near the mouth of a lateral valley of the Wye (Text-fig. 1). The Wye here pursues an approximately north and south course through a deeply excavated valley in Wenlock, Ludlow, and, further south, Old Red Sandstone rocks. Viewed from the commanding height of the Carneddau it appears very similar to the Chalford Valley, Stroud. At Aberedw it unites with the Aberedw Valley, which joins it almost at right angles. In pre-Glacial times the Wye flowed through this gorge, and then, as now, was joined at Aberedw by the Edw River; but instead of the subsequent Edw affecting its junction with the consequent Wye by way of the deep-cleft cut to the south of the bailey-castle-crowned tump south-west of the church (see Plate XXIX), it doubtless flowed Wyewards to the north. In other words, I think that this deep gorge of the Edw has been cut by the Edw River since Glacial times, that the valley to the north of the crag referred to was its pre-Glacial channel, and that this to the south is its post-Glacial one.

This change of channel was probably due to the ice that occupied the Wye Valley depositing debris from its lateral moraine across the mouth of the Aberedw Valley. To this heap was added terminal moraine matter from the Edw Glacier. While the ice was moving, the terminal moraine matter from the Edw Glacier would combine with that of the lateral moraine of the Wye, and trail southwards as the left-bank lateral moraine of that glacier. But a time would come when the southward movement of the ice would no longer continue, and Wye lateral moraine matter, *plus* the terminal moraine debris of the Edw Glacier, would accumulate in the mouth of the Aberedw Valley. As the rigorous climate of the Glacial Epoch ameliorated the ice thawed, and the moraine-blocked Aberedw Valley passed into the lake phase. The waters of the lake would become augmented by the melting ice and snow of the more elevated tracts, and the moraine dam would be overflowed. Such lakes as a rule evolve an overflow channel between the morainic material and the solid rock bank, and generally, rather naturally, on the downstream side.

Morainic material must thus be pictured stretching across the mouth of the Aberedw Valley. The water escaping over the southern end of the dam soon commenced cutting into the flaggy rocks of the Silurian, the purely erosive action of the swift-flowing water being accelerated by the filing action of the torrent-driven stones.

When the Glacial Epoch closed, a passage having been established, the River Edw did not attempt to revert to its pre-Glacial channel, but persisted in its cleft-like gorge and soon graded with the Wye.

Differential denudation has now lowered that part of the mouth of the Aberedw Valley, where the morainic matter occurs more than the crags along the right bank of the present Edw Gorge (Plate XXIX).

Standing on the summit of the old bailey-castle and looking down into the deep Edw Gorge, with its rocky banks and swift-flowing river, one cannot restrain feelings of admiration at this excellent illustration of how much work has been accomplished since the rigorous Glacial conditions drew to a close in these parts.

The photograph reproduced with this paper will convey a good idea of the flat ground occupied by the moraine-matter; the bailey-castle-crowned tump of Silurian rocks on the north side of the Edw Gorge, and the steep, wooded Aberedw rocks on the south side.

The material of which the moraine-deposit that occupies the mouth of the Aberedw Valley and stretches some way up the valley eastwards is composed is excellently exposed in a pit close by the Wye and in the lane-sides near the village school. Well-smoothed boulders of diabase-porphyrite and andesite from the craggy Carneddau and of Caban conglomerate from the neighbourhood of Rhayader are easily identifiable rocks amid the preponderating element of fissile and less-travelled slabs of Wenlock and Ludlow rocks. Small fragments and large are confusedly intermixed in characteristically morainic fashion in a matrix of finer material.

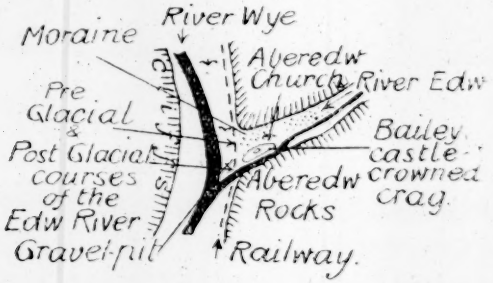


Fig. 1. Diagrammatic sketch of the country around Aberedw, near Builth Wells.

All down the Wye Valley between Aberedw and Boughrood well-defined patches of gravel form interrupted terraces, but at Boughrood there is a considerable spread rendered all the more apparent by an extensive pit at Boughrood Station. The railway traverses this bank of gravel and negotiates it by means of a steep gradient between the station and the Wye bridge, while the Wye escapes between the gravel patch and the steep western valley side, subsequently proceeding to describe the most noticeable horseshoe bend that there is in many miles of its course. Probably this gravel-deposit is one of several terminal moraines that mark the recession of the Wye Glacier.

The valley and tributary combs of the Upper Wye are rich in the products of the ice-action of the Glacial Epoch, and it is hoped that the phenomena described in the present paper will lend stimulus to their systematic investigation, which should result in the piecing together of a chapter of Glacial History no less instructive and valuable than that contributed by those who have studied the glacial phenomena of the Yorkshire moors.

VI.—The Diamond Matrices of Australia.

By J. Allan Thomson, B.A. (Oxon), B.Sc. (N.Z.), A.O.S.M., F.G.S.

SINCE the exhibition of the diamond in a dolerite at York and Mexico by Professor Edgeworth David, great interest has been aroused in the Copeton occurrence. Specimens of the rock and

concentrates washed from it were forwarded by the prospector, Mr. Pike, to several gentlemen who had expressed their desire to examine them, and amongst others to Professor Miers. It was my privilege, whilst at Oxford, to examine these specimens, and the results of this examination were conveyed in a letter to Mr. Pike. As he has published part of its contents in the *Australian Mining Standard*, it is desirable to place before British readers a more connected account, and at the same time to give an outline of the not very easily accessible Australian literature.

The rock in which the diamonds have been found comes from Oakey Creek, Copeton, about 18 miles south-west of Inverell, New South Wales. Diamantiferous alluvial of late Tertiary age is abundant in the district, and has been long worked. The matrix itself has been discovered in a tunnel driven in the granite floor of the alluvial. It was first described by the Government Geologist and identified by Mr. G. W. Card as a dolerite.[1] So far, only two diamonds have been obtained, as the prospectors are unable to obtain water to wash the decomposed rock that has been mined. Both these diamonds were exhibited by Professor David at York and Mexico, and no doubt has been expressed as to the genuineness of the discovery.

The geological occurrence of the dolerite has not yet been fully cleared up; probably it is a dyke, but Mr. Pittman was inclined to believe that it might be a small pipe. In one direction a drive reached granite after passing through 26 ft. 6 in. of dolerite, but in a direction at right angles to this it has a much greater extent. The rock shows excellent spheroidal weathering.

Professor David refers to the rock as a hornblende diabase,[2] but the two specimens examined by me agreed in containing only pyroxene as an original ferromagnesian mineral. Sections show the rock to consist for the most part of elongate quadrate prisms of felspar, on which are moulded ophitically a colourless or pale bistre augite, a little ilmenite and a greenish-yellow chloritic material. The felspar is twinned both according to the Carlsbad and albite laws, and is determined by Levy's method as a labradorite of medium basicity. The yellow chloritic material is resolved, between crossed nicols, into minute imperfect sphærocrystals, with positive elongation of the fibres and a moderately high birefringence. It includes rare octahedra of magnetite, more commonly minute globules of a yellow, isotropic iron-hydrate and rod-like growths of iron-oxide, but in the majority of cases it is entirely free from ferruginous inclusions. It generally occurs in larger patches than the augite, but its relation to the felspar is the same. The augite appears so fresh that some difficulty is found in explaining the chlorite as arising from its decomposition, and it appears equally probable that it represents an altered glassy base. It would be remarkable if large ophitic plates of hornblende were entirely decomposed to a chlorite free of ferruginous materials, while the pyroxene escaped alteration. Possibly the specimens supplied to Professor David were of a different nature to those here described,

[1] E. F. Pittman, Ann. Rep. Dept. Mines, N.S.W., for 1904, p. 137 (1905).
[2] T. E. David, *Sydney Morning Herald*, January 19 and 26, 1907.

and if so, it is desirable that a full microscopic description should be published. Under the circumstances, the rock will be here referred to as a dolerite, the term 'diabase' being discarded because of its ambiguity.

The following analysis, made by Mr. Mingaye in the New South Wales Geological Survey Laboratory, accompanied the specimens sent by Mr. Pike. In using this analysis it must be remembered that some of the minerals described below in the concentrates may possibly have been included. Thus the presence of Cr_2O_3 is probably explained by the inclusion of chrome-diopside.

					89·78
SiO_2	50·43		K_2O		1·23
TiO_2	0·82		H_2O-		3·82
Al_2O_3	14·72		H_2O+		3·89
Cr_2O_3	0·02		CO_2		1·67
Fe_2O_3	2·90		P_2O_5		0·22
FeO	4·59		SO_3		0·01
MnO	0·03		V_2O_5		0·03
MgO	6·67				
CaO	7·13				100·65
Na_2O	2·47				
	89·78				

Sp. gr., 2·58. Traces of SrO, ZrO_2, and Cl.
F, S, NiO, CoO, BaO, and LiO_2 absent.

The concentrates consisted of the following minerals, all previously recorded by Mr. Card:—plagioclase felspar, iron-ores, a pale bistre augite, calcite, pyrite, quartz, tourmaline, a pale-green augite and garnet. The first three minerals are doubtless constituents of the rock, while calcite and pyrite may be considered as arising from their alteration. The presence of quartz and tourmaline is, in all probability, to be explained by the inclusion of fragments of the granite through which the granite is intrusive. There remain the green augite and the garnet to account for.

According to Mr. Pike's account,[1] the abundance of small red garnets in the rock is a very striking feature, and he surmises that eclogite inclusions may be present. He also quotes Mr. André Levy Strauss for the inclusion of contact-altered mica schist, limestone, and shale, but the descriptions given are hardly convincing.

The principles which guided Messrs. Pike and O'Donnell in searching for the matrix seem well founded, and justify the hope that other matrices may be discovered. They remarked that the diamonds found in neighbouring claims often showed considerable variations in form and colour, and they concluded that this could arise only if the matrix were near. Waterworn boulders of a decomposed yellow rock were the only constituents of the gravels that seemed likely to be the home of diamonds (arguing from analogies with the yellow ground of Kimberley), and these led them up to the dolerite. Mr. Pike appears still convinced that his matrix is comparable to the blue ground of Kimberley.

Another supposed matrix of the diamond occurs at Ruby Hill, about

[1] A. R. Pike, "The Copeton Diamonds, New South Wales. In Matrix and Notes on the Alluvial Deposits": *The Australian Mining Standard*, January 27, p. 93, and February 3, p. 119, 1909.

12 miles south of Bingara, New South Wales, and has also been described by Mr. Pittman.[1] Ruby Hill, so named from the abundance of garnets, is a small eminence of about 80 feet in height, formed on one side by Carboniferous claystones and a quartz felsite dyke intrusive into them, and on the other by a volcanic agglomerate penetrated by several basalt dykes. The map accompanying the description might almost serve for one of the necks of East Fife. Both the agglomerate and the dykes contain nodules of a rock consisting of garnet, anorthite, and chrome-diopside, identified by Messrs. Card and Woolnough as eclogite. Mr. Pittman draws an analogy between the agglomerate and the blue ground of Kimberley, but instead of following Professor Bonney in ascribing the eclogite to waterworn fragments derived from a floor of crystalline schists, suggests that it may be "the deep-seated representative of the eruptives which found their way to the surface in volcanic pipes at both these places".

Ten small diamonds were said to have been derived from Ruby Hill, but latterly some doubt has been thrown on the genuineness of this statement, since washing operations have not been successful in bringing fresh specimens to light.[2]

Still another supposed matrix is now being prospected at Snodgrass, about 20 miles south-west of Delegate, New South Wales, close to the Victorian border.[3] This rock, of which a poor exposure is found at the contact of Silurian slates and sandstones and a granite intrusive into them, is supposed to resemble blue ground in being composed of angular fragments of various rocks lying in a serpentinous matrix, and especially in the presence of eclogite nodules. As no diamonds have yet been found in the rock or in any alluvial deposits in the district, Mr. Pittman is justly doubtful of the probability of success in the present explorations, but as will be shown in the sequel, his argument that "in view of the authentic occurrence at Oakey Creek, near Inverell, it seems more logical to search for diamonds, in this country, in hornblende diabase" may need modification.

It will be seen from the above account that Australian diamond prospectors are inclined to attach much importance on the discovery of blue ground, and further consider the presence of eclogite as an important indicator. The latter predilection is owing to the well-known discovery by Professor Bonney of diamond crystals within the garnet of the 'eclogites' of the Kimberley pipes. Messrs. Hatch and Corstorphine[4] do not share Professor Bonney's view as to the importance of these pyroxene-garnet nodules, and they, moreover, consider them as related to the basic secretions of plutonic rocks, and not as true eclogites. But even if diamonds are not plentiful in these nodules, Professor Bonney's descriptions leave no doubt that they do occur in them.

I have already suggested that the nodules of crystalline rocks found

[1] E. F. Pittman, "The Mineral Resources of New South Wales": Geol. Surv. N.S.W., 1901, pp. 392–5.

[2] E. F. Pittman, "Supposed Diamond-bearing Volcanic Pipe, Snodgrass, N.S.W.": *Australian Mining Standard*, April 7, 1909, p. 359.

[3] Loc. cit.

[4] F. H. Hatch & S. S. Corstorphine, *The Geology of South Africa*, 1905, p. 299.

in the blue ground may prove to be homogeneous inclusions of volcanic rocks, which are analogous to, but hardly the same as the basic secretions of plutonic rocks.[1] The apparent reason that this explanation has not been earlier put forward must lie in the comparative rarity of garnetiferous homogeneous inclusions. A brief survey of the known examples may be of interest. Lacroix describes a few occurring in alkaline rocks when these themselves contain melanite.[2] Zirkel describes certain garnet-wollastonite nodules in the basalts of the Rhine Valley, but explains them as inclusions of limestone which have undergone thermal metamorphism by the action of the magma (accidental xenoliths).[3] These two kinds of garnet nodules are hardly germane to this discussion, and there remain only three instances known to me which have a bearing on the so-called eclogites. Zirkel in the same paper[4] gives adequate reasons for regarding other garnet-felspar-augite nodules as early segregations from the basalt magma. I have described garnetiferous olivine, augite and hornblende nodules in the limburgite breccia of Kakanui. Finally it is almost certain that similar nodules occur in the necks of the Fife coast, for at Elie Ness, where hornblendic, augitic, biotitic, and felspathic nodules are abundant, garnets may occasionally be picked up in the agglomerate and on the beach. It is worthy of note that the two latter occurrences are in the agglomerates of limburgites, although felspathic basalts are present in both localities. From the descriptions already given, the so-called eclogites of Ruby Hill and Snodgrass appear to come under this category, and it is not improbable that the other eclogite occurrences of New South Wales, cited by Mr. Pittman,[5] may prove to be similar.

The presence of chrome diopside and garnet in the Oakey Creek dolerite is strongly suggestive of the occurrence of garnet-pyroxene nodules in this rock. The occurrence would not then differ so greatly from those of South Africa as has been supposed. The importance of this case is that we have direct evidence of the nature of the magma from which the nodules segregated.

These views are largely conjectural, but this paper will serve its purpose if it secures an adequate consideration of them when the full history of the Australian diamond matrices comes to be written. Should they be confirmed, instead of comparing the Australian occurrences to the South African, the reverse process may take place, and one may see in the diamond 'pipes' of the latter continent the necks of volcanic rocks such as limburgites, in which the accidental xenoliths and homogeneous inclusions have escaped excessive alteration, while the ultrabasic volcanic material has been completely serpentinised. The discovery of necks of mellilite-basalt already points in this direction.[6]

[1] J. A. Thomson, "Inclusions in some Volcanic Rocks": Geol. Mag., 1907, Dec. V, Vol. IV, p. 500.

[2] A. Lacroix, *Les Enclaves des Roches volcaniques*, Maçon, 1893.

[3] F. Zirkel, "Über Urausscheidungen in rheinischen Basalten": Abh. König. Sächs. Ges. d. Wiss., 1903, xxviii, p. 103.

[4] Loc. cit., p. 497. [5] Loc. cit.

[6] A. W. Rogers & A. L. du Toit, "The Sutherland Volcanic Pipes and their Relationship to other Vents in South Africa": Trans. S.A. Phil. Soc., 1904, xv, p. 61.

Although only one undoubted matrix is known in Australia, the wide distribution of diamonds in the alluvial deposits suggests that many others are present. The erosion of a dolerite dyke must of necessity be slow, and seems inadequate to supply the quantity already recovered from the gravels. Volcanic agglomerates seem more suited to explain this wide distribution, from their easy destruction by surface agencies. Moreover, in such aggregates diamonds are more likely to be plentiful, if one may argue from the distribution of other minerals of homogeneous nodules. For instance, both at Kakanui and Elie Ness large hornblende crystals may occasionally be found in the dykes traversing the agglomerates, but they are much more abundant by themselves as fragments in the agglomerate, and this is true of the minerals of most crystalline tuffs.

VII.—The Old Granites of the Transvaal and of South and Central Africa, by Cuthbert Baring Horwood, A.R.S.M., Assoc. M.Inst.C.E., F.G.S., with a Petrographical Description of the Orange Grove Occurrence, by Arthur Wade, B.Sc. (Lond.), A.R.C.S., F.G.S.

(*Continued from the October Number, p. 468.*)

MR. J. HAYS HAMMOND in his paper, "Gold-mining in the Transvaal, South Africa," read at the Richmond meeting of the American Institute of Mining Engineers in February, 1901, referring to this Old Granite, states: "There are at places intrusions from this enveloping granitic mass into the younger formations."

Mr. Dörffel called attention to the fact that it had never been proved to be intrusive in the Witwatersrand System, and expressed his opinion that it was not, although this assumed the existence of an Archæan formation, which apparently was wanting in the Transvaal yet existed in Cape Colony as the Malmesbury Beds.

In January of the following year, in supporting Mr. Dörffel's views, I showed[1] that in the case of the Orange Grove occurrence all the evidence indicated that there the granite is not intrusive in the Witwatersrand System.[2]

In March of the same year Dr. Corstorphine[3] described the exposure of Witwatersrand quartzite resting directly on the Old Granite on the farm Uitkyk in the Heidelberg district, where no veins are to be seen passing upward into it from the granite, and in the closest proximity to the granite the quartzite presents the same petrographical characteristics as elsewhere. Where the surface of the granite can be seen below the escarpment it gives the impression of a rounded and worn mass. From the evidence afforded from this occurrence he

[1] "Contribution to the Discussion on Mr. Dörffel's Paper, 'Note on the Geological Position of the Basement Granite,'" by C. B. Horwood: Trans. Geol. Soc. S.A., vol. vi, pt. vi, pp. 114, 115.

[2] The Witwatersrand System consists of the Upper and Lower Witwatersrand Beds; this division is purely an arbitrary one, and is placed at the base of the Main Reef Series.

[3] "The Geological Relation of the Old Granite to the Witwatersrand Series," by G. S. Corstorphine: Trans. Geol. Soc. S.A., vol. vii, pt. i, pp. 9–12.

maintained that the Old Granite is not intrusive in the Witwatersrand System; but that the latter was laid down on the granite.

Again, in December of the same year, Mr. E. Jorissen[1] described occurrences in the Central, Western, and Northern Transvaal, and just over the eastern border in Swaziland; and also in the Vredefort district of the Orange River Colony, where he maintained the Old Granite is intrusive into either schists or quartzites, as the case may be, older than the Witwatersrand System. He suggested that these quartzites and crystalline schists must be considered as the remnants of an Archæan formation in the Transvaal, the existence of which Mr. Dörffel had already assumed.

Simultaneously with Mr. Jorissen's paper another appeared by Dr. F. H. Hatch,[2] in which he pointed to the existence of sedimentary rocks, composing the hill range of Mount Marais, near Marasbastad, 8 miles south of Pietersburg, which have suffered great contact-metamorphism from the presence of the Old Granite, which has been intruded into them. He argued that these sediments are therefore older than the Witwatersrand System, since the latter was shown by Dr. Corstorphine to rest unconformably on the Old Granite. The author stated that his investigation of the Mount Marais rocks and a comparison of them with those of Barberton had led him to the conviction that these beds, for which he proposed the name of Swaziland Series,[3] are well represented in the Transvaal by the great series of schists comprising the rolling uplands of Swaziland, by the Moodies and Sheba Ranges at Barberton, and by the hill country near Marabastad. He also pointed out[4] that the pebbles of which the conglomerates of the Witwatersrand System are composed are derived from just such rocks as occur in this Swaziland Series.

Mr. H. Kynaston, Director of the Transvaal Geological Survey, in discussing these last two papers,[5] said he had a few months ago paid a flying visit to the rocks of Mount Marais; and went on to say that "the two papers had certainly conclusively proved that the Older Granite was intrusive in an older series of altered sedimentary rocks. One of the chief arguments of the author against the Mount Marais rocks being of Lower Witwatersrand age was that the Older Granite was not intrusive in these latter beds. This fact he did not feel quite satisfied in his mind as having been as yet conclusively proved, and further, there was always the possibility of separate masses of the Older Granite belonging to slightly different periods of intrusion. A short visit last year to the Venterskroon district had left the decided impression in his mind that the Vredefort granite was intrusive in the surrounding strata of Lower Witwatersrand age, and he had particularly noticed the corundum bearing and other

[1] "Notes on some Intrusive Granites in the Transvaal, the Orange River Colony, and in Swaziland," by E. Jorissen: Trans. Geol. Soc. S.A., vol. vii, pt. iii, pp. 151–60.

[2] "The Oldest Sedimentary Rocks of the Transvaal," by F. H. Hatch: Trans. Geol. Soc. S.A., vol. vii, pt. iii, pp. 147–50.

[3] This name has since been generally adopted.

[4] Loc. cit., p. 148.

[5] Proc. Geol. Soc. S.A., 1904, to accompany vol. vii of the Transactions, p. 62.

spotted and altered rocks described by Molengraaff, and he considered them as typical hornfels due to the contact action of the granite".

I notice that Mr. Jorissen[1] in dealing with the Vredefort occurrence shows the granite intrusive in certain schists, but does not prove that here it is not also intrusive in the overlying beds, and does not attempt to dispute Dr. Molengraaff's statement of the contact-metamorphism of the Hospital Hill Slates, or to criticize his explanation of the cause of the over-tilting of the strata in this district.

In March, 1906, Mr. H. Kynaston, Director of the Geological Survey of the Transvaal, in a paper entitled "The Geology of the Neighbourhood of Komati Poort",[2] states that in the Old Granite intrusions of igneous rock occur, the majority of which may be classed as dolerites, in the sense in which Teall employs the term, and that they are usually in a well-preserved condition, and constitute a distinct group from the far older basic intrusions, usually referred to as diabases, so common in some of the other formations, such as the Pretoria Series. He says they must be referred to the final stages of the period of volcanic action which marked the close of Karroo times.

In his paper of the following year, "The Marginal Phenomena and Geological Relations of the Granite north of Johannesburg," he says[3]—

"An interesting modification is found along the slopes of the north face of the Rand between Orange Grove and Bedford. This is the only locality along the Rand, so far as I am aware, where an actual contact can be seen between the granite and the base of the Lower Witwatersrand Series. In one or two other localities further west the granite, or rather its dioritic modification, can be seen within a few yards of the basement quartzites, but in the section between Orange Grove and Bedford we have a clear and well-defined contact exposed for a distance of about a quarter of a mile.

"This contact is perhaps best seen a short distance west of the western boundary fence of Bedford Farm, and 1½ miles east of Orange Grove. The normal coarse acid type of the granite crops out on the lower slopes of the escarpment, but within 2 or 3 yards of the contact it gradually assumes a foliated structure, which becomes more and more marked up to the actual contact, where the uppermost few inches of the granite are usually in a highly schistose condition. The line of junction is remarkably sharp, and the base of the quartzite presents a well-defined and smooth under-surface resting at an angle of about 35 degrees upon the granite. There is not the slightest indication of any intrusive behaviour on the part of the granite, such as characterizes its relation to the basic schists and the older sediments of the Moodies Series. There are no signs of any intrusive veins or pegmatites in the quartzite, or of the granite breaking across from one horizon to another. The whole appearance of the section is that of a younger series of sediments resting upon an older mass of granite. Moreover, the lowest few inches of the quartzite

[1] "Notes on some Intrusive Granites in the Transvaal, the Orange River Colony, and in Swaziland," by E. Jorissen: Trans. Geol. Soc. S.A., vol. vii, pt. iii, pp. 156, 157.

[2] Trans. Geol. Soc. S.A., vol. ix, 1906, p. 28.

[3] Trans. Geol. Soc. S.A., vol. x, 1907, pp. 51–61.

frequently contain small rounded pebbles, sometimes almost in sufficient quantity to constitute a 'banket', and occasional pebbles are also sometimes found at slightly higher horizons. The pebbles are of vein-quartz and quartzite; granitic fragments could not be detected with certainty.

"Apart from the presence of these pebbles, the basal portion of the quartzite is usually fine-grained and uniform in texture, though along a certain portion of the section it was seen to become coarse and gritty. These features recall those so often found at the base of the Black Reef quartzites, where they rest upon similar granite, and tend to the conclusion that the base of the Witwatersrand quartzite here constitutes a true basement bed, which has been deposited upon the granite."

On the other hand, he points out that the intensely foliated character of the granite along the junction is similar to the foliated marginal facies which is intrusive in the Swaziland System, and that its petrographical features tend to strengthen the resemblance. Also the planes of foliation usually, although not always, strike in a direction parallel to the strike of the overlying quartzites. Further, he says: "the porphyry-like facies of the granite along the line of contact is certainly suggestive of intrusive behaviour, but one cannot accept this fact alone as good evidence of intrusion without more definite and confirmatory indications in the field; whereas, as already pointed out, the field evidence leads distinctly to the conclusion that the quartzites were deposited upon the granite. Further, the large quartz grains in the coarse grit, sometimes found at the base of the quartzite, are seen under the microscope to consist of aggregates of quartz showing strain shadows, and resembling the quartz blebs seen in the foliated granite beneath, a fact which strongly suggests their source of supply, and further favours the conclusion of the later age of the quartzites." Personally, I think the foliation and porphyry-like facies alluded to suggest close proximity to the contact with beds belonging to the Swaziland System, the junction being hidden by the overlying and unconformable quartzites.

He also describes two small outliers of the Moodies Series, consisting of shales and quartzites, with associated basic schists and serpentines, and also quartz-felsites, some 3 miles west of Mulder's Drift, in which the granite is intrusive; and shows that the basic schists to the south and south-west of the granite mass form a sort of peripheral basic zone.

He calls attention to the foliated character of the granite along its contact with the older basic schists and quartz-felsites of the Swaziland System, also to the variations of the granite itself. Thus we have biotite-granites, hornblende-granites, and quartz-diorites; to the development either of biotite or hornblende, the one at the expense of the other; to the local development of foliated quartz-diorite along its margin, due to the magmatic segregation of the more basic minerals towards the cooler portions; to dyke-like intrusions of diabase; and to the occurrence of lines of crush in the granite, forming conspicuous ridge-like features, having a general north and south trend, along which foliated and crushed granite of an acid type is found well developed.

With reference to these lines of crush he says: "they consist mainly of reefs of massive vein-quartz, which forms their central portion, and this is usually flanked on either side by a narrow zone of crushed and highly-sheared vein-quartz and granite, both kinds of rock being often brecciated and crushed together. The central portions have also frequently been fractured and brecciated, the fragments having been recemented by a secondary deposition of siliceous material." He instances one which extends for a distance of 12 miles and occurs about half-way between the eastern and western boundaries of the granite mass. This sheared and crushed nature of the granite along its marginal portions and along the edges of the quartz reefs he attributes to earth-movements subsequent to the consolidation of the granite.

In September, 1905, Dr. F. W. Voit[1] briefly described the occurrence of various gneisses, such as mica, hornblende, protogine, augen, flaser, epidote, and garnet gneisses, granulites, eclogites, and similar rocks, which occupy vast areas in the Northern Transvaal, including the Limpopo Flats. He suggested that all the phenomena, including petrographical character of the rocks, their monotony, and enormous extension probably indicated that they represented a Fundamental Formation; perhaps a vast area of original granite which had been converted into gneiss as a result of enormous pressure. The following month, in a paper entitled "Gneiss Formation on the Limpopo",[2] he points out that in such an old and large continent we have reason to expect that there should exist a Fundamental Gneiss Formation, and that the petrographical character of the rocks of the Swaziland Series, in which the Old or Basement Granite is intrusive, is such that we cannot class them among those rocks which elsewhere are considered as constituting the basement or fundamental rocks on which the others have been laid down. That, in fact, this Swaziland formation very largely consists of arenaceous and argillaceous rocks, which must have been derived from a still older formation.

He then shows that such a formation, consisting of granite and gneiss, actually occurs and covers an area of at least 800 square miles in the Limpopo Basin. He tells us that the formation for the greater part consists of different varieties of gneisses and schists, among which also occur hornblende and pyroxene rocks, crystalline limestones, quartzites, hæmatites, and magnetites. The gneiss, he says, shades off into a non-foliated rock, which occurs in alternating bands, but is structurally a granite, and is only sparsely developed in comparison with the foliated rocks, and evidently belongs to the period and process of the granite formation, and cannot be looked upon as a later intrusion. He describes the gneissoid rock as being an aggregate of flesh-red orthoclase, quartz, and a greenish somewhat decomposed hornblende, the minerals occurring in long, stretched, alternating individuals, with a strictly banded arrangement, and sometimes showing evidence of having undergone much pressure;

[1] "Preliminary Notes on 'Fundamental Gneiss Formation' in South Africa," by Dr. Voit: Trans. Geol. Soc. S. A., 1905, vol. viii, pp. 106–7.

[2] Trans. Geol. Soc., 1905, vol. viii, pp. 141–6.

they, especially the hornblende, being bent, and even broken, while minute fault-planes run right across the cleavage. Among the various varieties he mentions the occurrence of corderite-gneiss, and also directs attention to the frequent occurrence of highly-crystalline limestone as well-defined layers in the gneisses,[1] and of thin beds of hæmatite and magnetite, which are often interbedded with the gneisses.

He lays stress on the fact that geologists who have made a special study of the origin of gneisses are inclined to look upon them as being of magmatic origin, as being, in fact, original granite foliated and turned into gneissoid rocks by enormous pressure caused by the contraction of the earth's crust. Also that northern geologists who have studied the old crystalline schists assume the existence of a granite older than all crystalline schists—forming the basement whereon the geological formations began to be built up, whilst they, during a long period of denudation, furnished by their detritus the material from which the sedimentary rocks could be formed. Two years later he states[2] that in the Limpopo district granite resembling that which is intrusive in the Swaziland Series also occurs and is intrusive in the gneiss formation, and that its intrusive nature can often be observed along the steep banks of the Limpopo River. Also that inclusions of crystalline, well-foliated rocks, such as coarsely-crystalline well-foliated hornblende rock containing very little felspar, augen-gneiss, etc., which certainly do not belong to the Swaziland Series, and which are apparently in no way related to the granite, occur as metamorphosed masses in the Old, intrusive, Granite. In the Vryheid district, for example, he found such a rock and also augen-gneiss occurring as metamorphosed masses in the Old Granite, which had evidently been caught up in it at the time of its intrusion. Rounded masses of hornblendic and augen-gneisses also occur in the granite between Melmoth and Eshowe in Zululand.[3]

In this connexion I might mention, that dark inclusions consisting of amphibolite or closely allied rocks, occur abundantly in the granite-gneiss of the Laurentian System of Eastern Canada, and that there is positive proof that some, and possibly all, of these are remnants of the walls or roof of the granite bathyliths which have fallen into the granite-magma, and have partaken of its subsequent movements.[4] Also the black inclusions in the granite-gneisses of the Adirondacks are considered to be broken masses of an older rock caught up by the granite-gneiss when the latter was still in a molten condition.[5]

[1] He gives an occurrence of calcite rock, which is interbedded between the schists near Zand River, as an example of a highly altered igneous rock. Probably the crystalline limestones in the gneisses have also originated from the alteration of igneous rocks.

[2] "Gneiss Formation in Africa," by Dr. F. W. Voit: Trans. Geol. Soc. S.A., vol. x, pp. 90–4.

[3] Loc. cit., p. 93.

[4] "On the Structure and Relations of the Laurentian System in Eastern Canada," by Frank Dawson Adams, D.Sc., F.R.S.: Quart. Journ. Geol. Soc., vol. lvi, No. cclv, pp. 133–5.

[5] "Report on the Crystalline Rocks of St. Lawrence County," by C. H. Smyth, jun.: N.Y. State Mus. 49th Ann. Rep., 1895, vol. ii (1898), p. 490.

In order to show the widespread areas covered by this gneiss formation, he points out that Dantz[1] maps the central and northern parts of German East Africa as an enormous area of gneiss, in which he distinguishes between the peripheral zones of gneiss of particularly well-foliated character and the central part of granitic character; and that Tornau noticed gneisses of every variety in the Uluguru Mountains, but that generally in other parts of the Colony through which he travelled coarsely-grained granite prevails, showing throughout the same uniform composition and character, without any signs of foliation, and this he called typical granite, which is probably identical with our Old, intrusive, Granite.

Mr. Tornau states that the gneisses are older than the granite; for instance, he found, towards the south of the Nyassa, rounded gneiss fragments of all varieties, with sharp contours, in the granite. Dr. Voit[2] says he found a similar gneiss formation in the interior of Angola, which he put down as Fundamental Formation, consisting of granite and coarse-grained gneisses, in which the granite was intrusive, and that these gneisses showed a remarkable resemblance to the foliated gneisses of the Limpopo. He further says that it appears that certain gneisses south of the Gansberg in German South-West Africa ought to be separated from the intrusive granites, and classed as an independent formation. He says it is interesting to the geologist who has seen more of Africa than the South to observe that the Swaziland Series with intrusive granite seem to prevail in the South of Africa, while proceeding towards Rhodesia and Central Africa the gneisses with intrusive granites predominate.[3]

Dr. Voit[4] also found the Old Granite intrusive in the gneisses of the Engoye Mountains in Zululand; and also correlates the gneiss formation (in which the Old Grey Granite is intrusive) of the 'Nkandhla district of Zululand with the granite-gneiss formation of the Limpopo. The Swaziland Series also occurs in the 'Nkandhla bush.

He concludes by stating that we therefore have two distinct formations in which the Old Granite is intrusive—a coarse-grained, highly-crystalline rock of well-foliated character, similar to the very oldest gneiss of Laurentian age, and of undoubted igneous origin; and the Swaziland Series, of undoubtedly sedimentary origin, with igneous sheets of diabasic rocks.

In discussing Dr. Voit's first paper on this gneiss formation of the Limpopo Flats, Mr. H. S. Harger[5] stated that he had been over this ground in the Limpopo region and that he had also come across a similar formation, consisting of hornblende-gneiss, garnet-gneiss,

[1] Paper read by Mr. Tornau before the Deutsche Geologische Gesellschaft, Berlin, March 6, 1907.

[2] "Preliminary Notes on 'Fundamental Gneiss Formation' in South Africa," by Dr. F. W. Voit (Trans. Geol. Soc. S.A., 1905, vol. viii, p. 107), and "Gneiss Formation in Africa", by Dr. F. W. Voit (Trans. Geol. Soc. S.A., 1907, vol. x, p. 92).

[3] "Gneiss Formation in Africa," by F. W. Voit: Trans. Geol. Soc. S.A., 1907, vol. x, p. 92.

[4] Loc. cit., p. 93.

[5] Proceedings of the Geol. Soc. of South Africa (to accompany vol. viii of the Transactions), 1906, pp. 57, 58.

magnetite-gneiss, mica-schist, and talcose-schist, on the borders of Natal and Zululand, near Krantzkop.

With reference to Dr. Voit's remark that the gneisses and granite are more predominant as one travels northwards towards Central Africa, a paper by Messrs. Preumont & Howe[1] on the Geology of Uelle and Lado Enclave (the north-easternmost provinces of the Congo Free State, and including the eastern portion of the basin of the Upper Nile, covering in all an area of some 80,000 square miles) is of great interest. Granite, well-foliated gneisses, mica-schists, and other metamorphic rocks greatly predominate, and are classed as primary rocks. In fact, post-Primary rocks occur only in the extreme western part of the region, about Buta on the River Rubi. The granite is intrusive in the gneisses, quartzites, and mica-schists. Remarkable deposits of hæmatite and magnetite also occur. From Howe's petrological description of the rocks, the granite and gneisses bear a marked resemblance to the gneisses and Old Granites of the Transvaal.

The following is his description of microcline-gneiss from the Lado Enclave:—"A cream-coloured, medium-grained, banded rock. The texture, as seen in the section, is granitic; there is no sign of foliation. Quartz occurs in fair-sized plates, also in blebs within the felspar (corrosion-quartz). Streaks of dusty inclusions are common. The felspars comprise abundant microcline, orthoclase, and plagioclase (oligoclase); albitic and periclinic twinning frequently occur together. Some of the felspars have schiller-structure, produced by rows of negative crystals. Micrographic intergrowths of felspar and quartz appear sporadically in small patches. A curious, dark-green, pleochroic variety of hornblende occurs in a few patches. Biotite is present, but is sparingly represented; it is often greenish in colour. A little sphene is associated with the mica. A few small rounded crystals of zircon are present, also short prisms of apatite."

A microcline-gneiss from between the Rivers Kwado and Aro he described thus: "Microcline in abundant large plates is the predominant felspar; there is also some plagioclase. Quartz occurs in irregular grains and as bleb-like inclusions in the microcline; fluid-inclusions are common in the quartz. Both a colourless and a dark-brown mica are present. Epidote is plentiful in rather large pale masses. Zircon and sphene are present, also small patches of chlorite in association with the mica. The foliation is well marked, even in the slide, and is accompanied by an approach to granulation and a sort of mortar-structure."

From these two descriptions the granites appear to be remarkably similar in petrographical habit to the Old Granites of the Transvaal. The prevalence of microcline-granite-gneisses and microcline-gneiss also suggests great similarity to the Old, Grey, Microcline Granites of South Africa.

Along the boundary of the Congo State and the Bahr-el-Ghazel a series of very coarse, pegmatoid, gneisses occurs, with large mica,

[1] "The Geology and Petrology of part of the Congo Free State," by G. F. J. Preumont & J. A. Howe: Quart. Journ. Geol. Soc., 1905, vol. lxi, pp. 641–66.

felspar, and quartz elements, and local developments rich in tourmaline, kyanite, and garnet. The authors state that the crystalline rocks of the eastern portion of the area described appear to be analogous in every way to the rocks of the same age in Uganda, British East Africa.

In the discussion on this paper Mr. Walcot Gibson stated that some of the rocks described recalled a sequence in Griqualand West. In this same connexion, some recent papers by Mr. J. Parkinson on the Geology of Southern Nigeria and Western Liberia are also instructive. Mr. Parkinson,[1] in describing the geology of Southern Nigeria, speaks of a basement-platform of crystalline rocks, and again of a basement-platform of gneiss and schists; and he divides the crystalline rocks into (1) foliated acid orthogneisses, which tend to lose their foliation and pass into granites, and when coarsely-crystalline have a pegmatoidal habit; and (2) unfoliated rocks consisting of many varieties of granite, of tourmaliniferous pegmatites, and of aplite-dykes. The petrographical characters of the schists suggest that they were originally sediments. The gneisses are said to be intrusive in them, but I suspect that later work will show that it is a younger granite which is intrusive in both schists and gneisses.

Dr. J. W. Evans, in discussing Mr. Parkinson's papers, said that these crystalline rocks showed considerable resemblance to those of Central Africa.

Dealing with Western Liberia, Mr. Parkinson[2] finds that most of the rocks consist of acid-gneisses (in which biotite is usually the sole ferro-magnesian mineral and microcline is common), garnet-schists, garnet-biotite-gneisses, granitic-orthogneisses, and foliated hornblende-schists, garnet-hornblende-quartz rock, magnetite-hypersthene rock, and chlorite-schists, etc. He states that the probable igneous origin of many of the gneisses and associated rocks is suggested by an exposure at Von on the St. Paul River, where a coarse quartz-felspar vein of pegmatoidal habit cuts clearly across the foliation of the biotite-gneiss, but is apparently an integral part of the complex. He maintains that here also the gneisses are intrusive in the schists.

As in the Congo Free State Preumont[3] found hæmatite and magnetite deposits associated with the old crystalline primary rock, so here, in Western Liberia, Parkinson found hæmatite-schists associated with the gneisses. As already noted, Voit[4] also found thin beds of hæmatite and magnetite interbedded between the gneisses on the Limpopo.

Messrs. Chalmers and Hatch,[5] in describing the geology of

[1] "The Post-Cretaceous Stratigraphy of Southern Nigeria," "The Geology of the Oban Hills (Southern Nigeria)," "The Crystalline Rocks of the Kukuruku Hills (Southern Nigeria)," all by J. Parkinson: Quart. Journ. Geol. Soc., 1907, vol. lxiii, No. ccli, pp. 308–17.

[2] "A Note on the Petrology and Physiography of Western Liberia," by John Parkinson: Quart. Journ. Geol. Soc., 1908, vol. lxiv, No. ccliv, pp. 313–16.

[3] Loc. cit.

[4] "Gneiss Formation on the Limpopo," by F. W. Voit: Trans. Geol. Soc. S.A., 1905, vol. viii, p. 145.

[5] "Notes on the Geology of Mashonaland and Matabeleland," by J. A. Chalmers and F. H. Hatch: Geol. Mag., 1895, Dec. IV, Vol. II, No. ccclxxi, pp. 193–203.

Mashonaland and Matabeleland, show that the bulk of the country consists of granite, and the remainder chiefly of metamorphic rocks, chiefly chlorite- and hornblende-schists, epidiorites, actinolite rocks, diabases, dolerites, and other igneous rocks. It is their opinion that the schists are, at all events for the most part, derived from basic igneous rocks which have invaded the granite, and do not represent ancient sediments deposited on a granite floor. They consider the granite and schists constitute a portion of that ancient floor of granite and metamorphic rocks that elsewhere underlie the subsequent sedimentary or igneous accumulations.

As illustrating the widespread distribution of Old Granites and Gneiss in Southern Africa, Mr. J. Kuntz,[1] speaking of Little Namaqualand, says: "Like everywhere else in South Africa, the base of all stratified rocks is formed by granite and gneiss with its varieties and developments into the old crystalline schists."

With reference to the southern part of Great Namaqualand he states that towards the north the Archæan rocks become more covered by younger strata, and the zone of granite-gneiss is confined to a narrower strip along the coast; and also that in the northern part of Great Namaqualand almost the whole country consists of old schists, varying from the gneiss to mica-schists, amphibolite-schists, quartzites, and chlorite-schists. He says that in the granite zone of the Swakop River, situated to the north and north-west of the schistose zone of the Kuisib Valley, the granite is intrusive in the old schists, but only near the basal granite-gneiss, in which the granite is also intrusive. He remarks that it appears as if formerly, when the crust of the earth was very thin, the folding movement, such as that which tilted up the old schists, caused outbreaks of the underlying granitic magma.

Dr. F. W. Voit,[2] in describing the geology of German South-West Africa, divides the whole country into a gneiss and schist zone and a gneiss-granite zone, pointing out that there are intrusive masses of granite, especially frequent in the western half of the country, containing large fragments of gneiss and schist, which undoubtedly belong to the gneiss and schist zone. In the gneiss-granite area there is a strong predominance of granite. He points out that certain coarse-veined gneiss is merely a structural variety of the granite, and also that a special feature of the district is the occurrence of crystalline limestones, some of which are interbedded in the schists, and which he regards as true members of the schist formation.

With regard to the gneiss-schist area, he remarks that the gneisses and mica-schists appear to be connected with each other by almost imperceptible gradations, and that, moreover, a certain sequence is apparent, which he illustrates by an ideal cross-section from Jakalswater to Gansberg, a distance of about 85 miles, in which from below upwards we have—

[1] "Copper Ore in South-West Africa," by J. Kuntz: Trans. Geol. Soc. S.A., 1904, vol. vii, pt. ii, p. 70.

[2] "A Contribution to the Geology of German South-West Africa," by Dr. F. W. Voit: Trans. Geol. Soc. S.A., 1904, vol. vii, pt. ii, pp. 77–94.

(1) *Granite*, intrusive in the gneisses and schists.
(2) *Schistose gneisses*, with an interstratified calcium-silicate-hornfels rock.
(3) *Mica-schists*, with highly crystalline limestones and clay slates interbedded.
(4) *Amphibolites*, with graphite-quartzite-schists and mica-schists.
(5) *Chloritic and sericitic schists.*

He also says that varieties of granite frequently penetrate one into the other.

Mr. A. W. Rogers,[1] Director of the Geological Survey of Cape Colony, has described the masses of granite and gneiss of Griqualand West and of the Cape Colony, by far the greater proportion of which occurs in the north-west of the Colony, but so far he had found no evidence of a difference in age between the granite and gneiss. As already stated, he is, however, inclined to admit a difference in age between the granulites of the Prieska district and the normal granite and schists; this will be referred to again later.

He mentions the occurrence in the south-western districts of rocks of more basic composition than granite as being intrusive in both the granite and Malmesburg Beds. Here the granite is intrusive in the Malmesbury Series and the Namaqualand Schists, which are both correlated with the Swaziland Series of the Transvaal.

(*To be concluded in the December Number.*)

VIII.—Notes on the Pre-Glacial Rock-Platform on the Wexford Coast.

By F. R. Cowper Reed, M.A., F.G.S.

THE occurrence of a pre-Glacial marine terrace and raised beach along the coast of the south of Ireland was described by Messrs. Wright & Muff in 1904,[2] and its development in the eastern part of co. Waterford was the subject of two short papers by the author in 1907[3] in this Magazine. Messrs. Wright & Muff (op. cit.) observed the same raised beach only in the south-eastern portion of co. Wexford, so that its recognition this summer by the author further north along the east coast of Ireland deserves recording, for it has been traced for several miles to the north and south of Courtown Harbour, and its height, characters, and relations to the overlying deposits show that it is a continuation of the same feature. The first locality to be mentioned is about 3 miles to the south of the village of Courtown, where relics of it are preserved between Roney Point and Salt Rock; it is still more distinct as a rock-terrace a little further north at Pollshone Head and Breanoge Head, but in the bays between these points the conditions are not favourable for its exposure, as there are no rocky cliffs, only extensive sand-dunes stretching

[1] *An Introduction to the Geology of Cape Colony*, by A. W. Rogers, 1905 (Longmans, Green, & Co., London).
[2] Wright & Muff, Proc. R. Dublin Soc., 1904, vol. x, pt. ii, pp. 250–324.
[3] Reed, Geol. Mag., 1907, Dec. V, Vol. IV, pp. 17, 549.

along the shore. From Courtown Harbour northwards for about 2 miles to Duffcarrig Rocks sand-dunes are similarly developed, forming a nearly continuous line of ridges rising to heights of over 50 feet. Thick drift deposits occur behind them, but no pre-Glacial cliff or platform is exposed. At Duffcarrig Rocks solid rock again appears forming the headland, and we can recognize remnants of the rock-cut shelf in a much eroded and fissured condition. From here onwards to Ballymoney, about 1½ miles to the north, fragments of it may be detected in the reefs running across the foreshore, but in no place here is it continuously or well preserved, having been much dissected by later marine erosion. It is on the north side of Ballymoney, where the cliffs and foreshore are largely composed of solid rock, that we find it in the most perfect condition. Especially is this the case near the mouth of Kildermot Glen, where it forms a distinct shelf or platform 10–30 feet wide, and is cut across the edges of the steeply inclined Lower Palæozoic sedimentary and igneous beds. On this platform rest patches of the old beach deposit, the shingle being cemented together into a hard conglomerate and adhering in places firmly to the platform itself. The pebbles in it are mostly rounded and small, but a few are subangular and measure as much as 6–8 inches in length. The platform ends abruptly at the cliffs behind, the upper portion of which is composed of boulder-clay and glacial gravel; but it can be proved to pass in below these deposits which rest upon its surface. The pre-Glacial cliff is not exposed. When followed further north beyond Kildermot Glen, the rock-platform attains a general width of 25–30 feet, forming an almost horizontal terrace, 10–15 feet above high-water mark, with a gentle slope seawards, and it has been planed down to a remarkably uniform level across the edges of the steeply dipping and highly cleaved Ordovician calcareous flags, etc. A few large transported boulders of non-local rocks are found resting on the surface of the platform, either partly embedded in the drift of the cliffs or weathered out and lying loose on its surface. One such large subangular mass of diorite measured 6 × 3 × 2 feet, and another block of coarse grey granite measured 3 ft. 6 in. × 3 ft. × 2 ft. 6 in. in size, both of them being typical erratics. The pre-Glacial platform has been completely worn away further north towards Kilmichael, where the softer purple and green laminated slates set in, the cliffs composed of these beds rising up nearly vertically from the present beach-level. In Kinahan's *Geology of Ireland* (1878), p. 253, there is a statement that the "12 ft. beach" is seen in many places between Bray Head and Carnsore, and it is probable that he here refers to the above described pre-Glacial platform.

IX.—On River Development in Mid-South Wales.

By L. Richardson, F.R.S.E., F.G.S.

THE Lower Severn Valley has been classic ground to students of river-development ever since Professor W. M. Davis visited and applied those principles of river-development which he had found so illuminating in his own country. Recorded in print, and

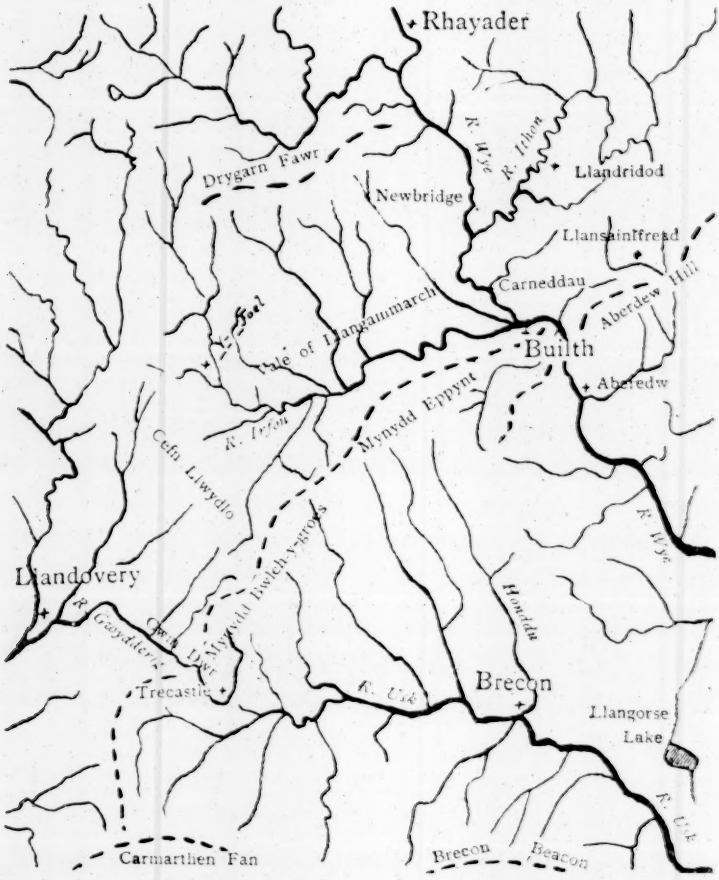
developed by Mr. S. S. Buckman and others, these views have met with much support, and certainly have the advantage of explaining many otherwise unintelligible phenomena.

In brief, as far as the Lower Severn Valley is concerned, the exponents of this theory hold that the valley of the Lower Severn was once non-existent; that the beds now terminating in the Cotteswold escarpment once extended much further west, up to, if not beyond, the borderland of the Palæozoic rocks. And not only did these rocks extend much further west and fill up the present Lower Severn Valley, but other deposits of great thickness also passed westwards above them. These Neozoic rocks were doubtlessly uplifted to form a great coastal plain gently sloping to the south-east. Over it the initial drainage ran in channels, usually, as one would expect, with an approximate direction from north-west to south-east. These original consequent-streams followed the ordinary course of river-development, deepening their channels, developing subsequents, capturing, and being captured.

Slowly and surely, however, whilst this development was proceeding, the theory has it that the Severn was cutting its way backwards from the south-west, capturing the transfluent consequent-streams one after the other, diverting the waters to the west of the elbows of capture into its own channel, and causing the beheaded streams to take their rise at some point to the east of the place of capture. In this way a divide was initiated between the capturing river and the beheaded streams. Thus had the Cotteswold escarpment its genesis, and as obsequent-streams were developed in the old consequent notches immediately to the east of the points of capture, it was caused to proportionately retreat. Further development has produced the mature valley of the Lower Severn, with its fault-block hills of Bredon and Woolston, the butte-like Churchdown Hill, the conical Robins'-Wood Hill, and the cuesta of the Cotteswolds. Away to the south-east, clearly visible from many of the eminences of the Cotteswold Hills, stretches the white Chalk escarpment.

In the heart of Wales, centred round Builth Wells, the present river-systems are in a prior phase of development of a subsequent cycle to that which has been reached in Gloucestershire and the adjacent counties. In many parts of Wales, as is so well seen from the Arans and Cader Idris, the rejuvenated rivers are actively engaged in dissecting the well-known peneplain. The case is not absolutely parallel, of course, although it sufficiently approximates to merit comparison. Standing on such a hill as Y Foel, north of Llanwrtyd Wells, and looking toward the south-east, one sees the channelled escarpment of the Wenlock and Ludlows, capped with the basement-beds of the Old Red Sandstone, which has been pictured so well by Murchison. The combes are not much more than storm-channels. They are not like the more mature combes of the Mid-Cotteswolds, for they are in a prior phase of development. From the Mynydd Bwlch-Y-Groes flows the Dulas River north-westward to the Irfon, which continues to flow in the same direction along the foot of the great Mynydd Eppynt to join the Wye near Builth. The Mynydd Eppynt declines to the south-east, and is drained by

a number of beheaded consequent-brooks that flow into the east- and west-running River Usk. The Usk runs eastwards, from the foot of the dark towering Carmarthen Fan, past the Fans of Brecon, and so into its broader valley at Crickhowel and Abergavenny.



Sketch-map to show the river-distribution in Mid-South Wales. The Towy-Bran system is that about Llandovery. (For Llandridod read Llandrindod; and for Aberdew Hill, Aberedw Hill.)

The River Wye, that flows south-eastwards from lone Plinlimmon, past Builth Wells, and down the deep Erwood Gorge, is suggestive of what the early Severn-to-Coln river was like when its course was by way of Upton-on-Severn, Tewkesbury, the line of the Swilgate, and so through the Chelt Valley and into the present Coln. With Newbridge-on-Wye occupying a corresponding site to Tewkesbury it is not hard to picture in the Ithon the subsequent Stratford-on-Avon.

Builth Wells corresponds in position to Dowdeswell in the Chelt

Valley; the hills that are grouped around the Carneddau to the Cleeve-Hill plateau; the Llansaintfread Valley to that of Sevenhampton; and the Aberedw Hill and its northern prolongation to the hills that form the east side of the Sevenhampton Valley.

Such was probably the state of the river-distribution in the Vale of Gloucester before the River Severn cut its way back.

The Severn captured the consequent that flowed from Upton to Andoversford at Tewkesbury, and brought about that river-distribution which has not greatly changed at the present time.

The River Bran, the north-easterly directed tributary of the Towy, will effect in time in the Vale of Llangamarch changes similar to those that the Severn has in the Lower Severn Valley. It is not difficult to see that a further backward development will bring about the capture of the Upper Wye; the diversion of that portion of the Wye which is above Newbridge into the capturing Towy-Bran River; the resultant beheading of that portion of the Wye to the south-east of the elbow of capture; to be followed by the initiation of an obsequent-stream up the Builth-Wells Valley, and the recession of the source of the beheaded Wye. The comparison could be carried further, but it will be easy for those who know about the state of river-development in the neighbourhood of Andoversford, near Cheltenham, to institute the few minor comparisons that remain.

The undulating ground that separates the progressing Bran from the receding Cledan and Dulas tributaries of the Irfon is excellently viewed from the lofty summit Y-Foel above Llanwrtyd Wells. On the south side the ground falls steeply towards Llandovery.

The Towy River has obviously effected an important capture at Llandovery. Once no doubt the River Usk commenced its course considerably further west, flowed across the then non-existent Towy Valley at Llandovery, and *via* the deep Cwm Dwr found its way past the site of the present Brecon. Westwards through the greater length of the Cwm Dwr now flows the obsequent Gwydderig, and eastwards a tributary of the consequent Usk that is gradually diminishing in length. In this neighbourhood there are in progress some very pretty examples of river-capture. Southerly and south-easterly directed tributaries of the Usk are being encroached upon by the growing Gwydderig, and abrupt elbows of capture are seen comparable with those observable in the Stroud area, where the obsequent Frome, developed from the Severn, has captured such original south-easterly directed tributary-streams of the Thames as that which flows down the Edgeworth Valley.

The way in which the comparatively broad valeland around Cilmery has originated through the development of the subsequents Irfon and Ithon may possibly suggest an explanation for the somewhat broad valeland expanse around Churchdown, Cheltenham, and Tewkesbury, and its contraction to the south towards Berkeley. When the Towy has overcome the intervening undulating ground in the neighbourhood of Cefn Llwydlo it will make comparatively rapid development, for it will capture the head-waters of the Irfon and invade the ready-excavated valley of Llangamarch. At first, as in the Lower Severn Valley near Berkeley Road Junction, the Towy Valley will be

constricted, but after that it will open out again like the Vale of Gloucester does in the neighbourhood of Churchdown, Cheltenham, and Tewkesbury.

Further details of the development of the rivers in Mid-South Wales must be left for local observers to work, but there is one broad feature to which passing reference may be made. It is the noticeable crescentic sweep of all those important rivers, that, working their way backwards, are effecting such radical changes in the river-distribution of Wales and the neighbouring counties of England. Starting down in the south-west they work their way north-eastwards and then gradually curve round north-westwards.

The Shannon in its crescentic course has nearly traversed Western Ireland. The Teify has almost isolated with the lower reaches of the Ystwyth a somewhat Ireland-shaped mass of Wales. The Towy seems engaged on developing a similar crescentic course, and the great Severn seems bent on making Wales another Ireland. With water stretching from Dee to Severn there would be the replica of the waters that now part Wales from Ireland.

X.—Optical Peculiarities in Phlogopite.

By T. Crook, Assoc.R.C.S., F.G.S.

IT frequently happens that micas exhibit small basal cleavage rifts of roughly circular shape, and these may be so numerous as to render opaque or feebly translucent a plate which would be otherwise quite transparent. The so-called silver-amber mica of the mica trade, a variety of phlogopite which is highly prized for its low conductivity, apparently owes its silvery sheen to the presence of these cleavage rifts, which overlap each other to a considerable extent, and reflect the light copiously. The presence of these basal cleavage rifts in silvery phlogopite is rendered quite obvious when a plate is examined under the microscope in ordinary light, by the interference rings seen round the borders of the rifts. Such a plate of silvery phlogopite exhibits a peculiar phenomenon in consequence of the presence of these rifts.

If a plate of suitable thickness, say 0·5 mm. or so, be taken, it will be found to be opaque or only feebly translucent when examined in ordinary light in such a way that the plate is normal to the line of vision. If the plate be now turned about a horizontal line, so that it slopes towards the observer, it will gradually become more transparent, the degree of transparency reaching its maximum at an angle of about 45°, and diminishing as the plate approaches the horizontal position. This greater degree of transparency in an oblique position, in spite of the apparently greater thickness of the plate which the light has to traverse, is a rather puzzling feature, and one which would scarcely be anticipated. It only occurs in those pronounced silvery types in which the rifts are exceedingly numerous and overlap extensively. The phenomenon seems to be due to the fact that, in consequence of the overlapping rifts, light can only be transmitted through the plate by a series of oblique

internal reflections; hence rays cannot emerge freely at right angles to the plate.

Further, if a plate of brown phlogopite be rotated in its own plane when in an oblique position, it exhibits axis-pleochroism, the axial colours being the same as those observed when the plate is examined with a nicols prism or a dichroscope. The varieties which show this axis-pleochroism in ordinary light to best advantage are the rich brown phlogopites, which show the pronounced axial tints on the base.

A plate of coloured muscovite or ordinary biotite, if examined in the manner here described, shows no pleochroism.

A basal cleavage plate of brown phlogopite therefore provides an instance of a mineral which exhibits axis-pleochroism when examined in ordinary light, without the use of a polarizer or a dichroscope.

NOTICES OF MEMOIRS.

I.—Preliminary Note on the Classification of the Permian of the North-East of England.[1] By David Woolacott, D.Sc., F.G.S.

SEDGWICK, Howse, and King classified the Permian according to the nature of its stratification or of the structures occurring in it; but as the bedding of the different divisions is often alike, and as the structures—whether concretionary, brecciated, pseudo-brecciated, or cellular—are not confined to particular horizons, divisions named on this basis are misleading and unsatisfactory. The use of the term 'fossiliferous' to mark off a division is also inadmissible. In the following classification the limestone is typically developed at the place the name of which is used to designate a group of strata. The divisions in descending order are—

Middlesbrough Red Beds with Salt.—Red marls, marly sandstones and lenticular beds of salt, anhydrite, and gypsum with fœtid fossiliferous magnesian limestones. 300 feet.

Roker Limestone.—Yellow limestone, regularly bedded; some beds compact, others formed of minute hollow spheres. 100 feet.

Fulwell Rocks.—Bedded yellowish and brownish concretionary (of various types) and non-concretionary limestones, in places highly fractured and brecciated; cemented crush breccia occurs locally. Base often much disturbed by beds from below being forced into it, and by falling of lower layers into fissures and gashes. Irregular beds of amorphous marl are associated with these beds. Two fossiliferous horizons occur: one of fish remains at Fulwell, and the other of invertebrata at Byers Quarry. 150 to 200 feet.

Marsden Rocks.—Bedded yellow and brown limestones, slightly concretionary in places. Irregular masses of white limestone resembling Mountain Limestone occur. Brecciated beds (cemented crush breccias) occur at different horizons. In places highly folded and fractured, but sometimes little disturbed. Breccia-fissures and breccia-gashes

[1] Abstract of Paper read at British Association Meeting, Winnipeg, in Section (C) Geology, August, 1909.

are found principally in this division. It is sometimes 'cellular', due to solution of fragments out of cementing material of brecciated beds. This horizon has been a zone of thrusting, the amount of brecciation being determined by the relative compressive strength and rigidity of the strata. A flexible limestone occurs near the top of this division. 150 to 200 feet.

Claxheugh Limestone.—Yellow, earthy, friable, and crystalline limestone. Generally unbedded, in places very fossiliferous, sometimes brecciated (crush breccia) and highly fractured. Its upper surface is very irregular. Some of the brecciated beds between Frenchman's Bay and Marsden, on Tynemouth Cliff, and at Blackhall Rocks are included in this division. Outcrops roughly parallel to coast as a continuous band. Brachiopods and most of the other genera of Permian fossils stop at this horizon in Durham. 50 feet.

Houghton Limestone.—Regularly bedded, thinly at base, more coarsely above. Top layers often highly displaced and tilted up; in one or two places it is entirely thrust out of position. Thickens greatly from north to south of county, and width of outcrop increases. Often full of geodes. 10 to 400 feet (?).

(The total thickness of magnesian limestone proved by boring is about 800 feet.)

Marl Slate.—Greyish, yellowish-brownish, and blackish arenaceous and argillaceous laminated limestone. Numerous fish remains. 3 or 4 feet thick.

Thin band of calcareous clay a few inches thick.

Yellow Sands.—An incoherent sandstone generally yellow along outcrop, occasionally variegated (iron oxides and manganese dioxide). In pit sections often greyish or bluish. Very variable in thickness. Top originally regular, but floor on which it rests irregular. Generally false-bedded, although in places, especially near the top, it is regularly bedded. Grains rounded. 0 to 150 feet.

II.—Limestone Unconformities, and their Contemporaneous Pipes and Swallow-holes.[1] By E. E. L. Dixon, B.Sc., F.G.S.

CALCAREOUS rocks differ from other commonly occurring types in being appreciably soluble in atmospheric waters, and, in consequence, being eroded along underground channels where situated above saturation-level. Thus it is that one of their most striking physiographic characteristics is the occurrence in them of numerous caves and swallow-holes, of all sizes and shapes, often containing either debris of overlying rocks or deposits formed in them *in situ*. It is the purpose of this note to draw attention to the way in which this characteristic is reflected in the nature of certain unconformable junctions of limestones with younger rocks.

Unconformities may be divided, for our purpose, into two groups. In the first the underlying rocks have an approximately plane upper

[1] Abstract of Paper read at British Association Meeting, Winnipeg, in Section (C) Geology, August, 1909.

surface, the plane of the unconformity, and have evidently been base-levelled, by either marine denudation or peneplanization, before the deposition of the upper set upon them. With this group any limestones which occur below the unconformity appear to be devoid of pipes or swallow-holes contemporaneous in origin with the plane of the unconformity. Example: the junction of the Carboniferous Limestone with Triassic or Jurassic formations at most places, such as Upper Vobster, in the Bristol district, already described by many authors.

In the second group the rocks below the unconformity have not been maturely eroded before the deposition of those above, and the junction may in consequence be very uneven. Where the underlying rock is limestone the unevenness becomes most marked, for there the junction is complicated by pipes and swallow-holes contemporaneous with the unconformity and filled with material similar to that of the overlying formation, which has been deposited in them *in situ*. An example in which the unconformity, and consequently the piping, has been but slight is afforded by the junction of the upper and lower subzones of the *Syringothyris*-zone of the Carboniferous Limestone—i.e. by the mid-Avonian unconformity—at West Williamston, in Pembrokeshire.[1] There the basement-bed of the upper subzone fills pipes, up to 8 feet deep, in the upper part of the Caninia-oolite (the top of the lower subzone) below, the evidently undisturbed state of both the in-filling and the rest of the basement-bed above showing that the pipes have been formed before the deposition of the upper subzone. At a short distance from West Williamston the pipes in the oolite disappear as we approach the area characterized by continuous deposition of the Avonian; but at Pendine,[2] in the opposite direction, where the unconformity in the middle of this formation is greater than at West Williamston, the piping has extended for a greater depth into the limestones below.

A still more advanced stage of solution-erosion is shown by the Carboniferous Limestone at Ifton, in Monmouthshire, near Severn Tunnel Junction. The unconformity in this case occurs between the Carboniferous Limestone and the Millstone Grit; in the former have been eroded large steep-sided cavities, comparable only with swallow-holes, as well as small pipes resembling those at West Williamston, and both swallow-holes and pipes have been filled with an original deposit of Millstone Grit. This occurrence is the more interesting because the Carboniferous Limestone and the Millstone Grit have subsequently been covered up with Trias, but the junctions of both with the latter form an even surface, evidently a base-levelled plane, below which there are no contemporaneous—i.e. Triassic—pipes in the limestone.

Finally, an extreme case of solution-erosion preceding unconformable deposition on limestone is afforded by huge breccia-filled cavities in the Carboniferous Limestone of Pembrokeshire.[3] These cavities

[1] *Summary of Progress for* 1906, Mem. Geol. Surv., 1907, p. 55.

[2] *Summary of Progress for* 1902 (p. 43), 1904 (p. 44), and 1905 (p. 55); and "The Country around Carmarthen" (in the press), Mems. Geol. Surv.

[3] *Summary of Progress for* 1904, Mem. Geol. Surv., 1905, pp. 46–7.

often extend from top to bottom of cliffs ranging up to more than 100 feet in height, and in some cases continue horizontally for over 100 yards. They are almost completely filled with blocks of limestone, of all sizes up to masses weighing hundreds of tons, which have fallen from the roof and sides, but also contain a little interstitial Triassic material *in situ*. The formation of the cavities, therefore, preceded the deposition of the Trias, and took place during the long period represented by the great unconformity between the latter and Carboniferous rocks. In this district, most, if not all, of the succeeding younger formation (the Trias), deposited on the upper surface of the limestone, has been removed, but there is evidence that that surface was a base-levelled plane. This belief, however, does not invalidate the conclusion that such planes are devoid of contemporaneous swallow-holes, because the plane which is believed to have existed in this case must have truncated some of the breccia-filled cavities, and therefore have been of later origin.

III.—Investigation of the Igneous and Associated Rocks of the Glensaul and Lough Nafooey Areas, Co. Galway.[1] By C. I. Gardiner.[2]

MR. C. I. GARDINER and the Secretary visited Connemara in April and completed their field work on the Glensaul district, commencing, in addition, to map the Lough Nafooey district.

The Glensaul district is a small one, measuring only about 2 × 1 miles. It is about 3 miles south-west of the southern extremity of the Tourmakeady district, recently described,[3] of which it is clearly a continuation, the type of sedimentary rock met with in the two being practically identical. The general succession is:—

III.	?*Bala Beds*—conglomerate and sandstone. These have not been studied.		
II.	*Llanderlo Beds.*		
	(5) Calcareous gritty tuff, passing in places into fairly pure limestone, and enclosing bands and patches of limestone breccia and bands of highly fossiliferous limestone, which in some cases has been shattered by earth movement . . .		Thickness doubtful.
	(4) Very coarse tuff or breccia mainly composed of felsite fragments		750 feet.
	(3) Tuff coarse and fine with occasional patches of calcareous beds		150 feet.
	(2) Great felsite sill of Tonaglanna and Greenaun .		1200 feet.
	(1) Tuff with some grit		600 feet.
I.	*Arenig Beds.*		
	(4) Coarse grit		150 feet.
	(3) Fine grit and tuff associated with black chert, graptolitic shale, and a prominent band of breccia 30 feet thick		Thickness doubtful.
	(2) Coarse grit		110 feet.
	(1) Coarse conglomerate		About 600 feet seen.

[1] Abstract of Paper read at British Association Meeting, Winnipeg, in Section (C) Geology, August, 1909.

[2] Report of the Committee, consisting of Professor W. W. Watts (Chairman), Professor S. H. Reynolds (Secretary), Mr. H. B. Muff, and Mr. C. I. Gardiner. (Drawn up by Mr. C. I. Gardiner and the Secretary.)

[3] Quart. Journ. Geol. Soc., 1909, vol. lxv, pp. 104–53.

The black shales have yielded the following considerable series of graptolites, which have been kindly determined by Miss G. L. Elles, D.Sc., and indicate the zone of *Didymograptus extensus*. The associated cherts contain radiolaria :—

Graptolites from the Arenig Beds of Glensaul.

Dictyonema, sp.
A Dendrograptid.
Tetragraptus pendens, Elles.
T. Amii, Lapworth M.S.
T. quadribrachiatus, Hall.
Clonograptus Lapworthi, Rued.
Thamnograptus, sp.
Didymograptus extensus, Hall (common).
D. filiformis, Tullberg.
D. fasciculatus, Nich.
D. bifidus, Hall.
D. gracilis, Törnquist.

In the Llandeilo rocks, both limestone and tuff, a large number of generally rather fragmentary fossils was found, which are being determined by Mr. F. R. Cowper Reed.

The crystalline igneous rocks, all of which we believe to be intrusive, are by no means so varied as in the Tourmakeady district, and are practically limited to one broad band of felsite, which is noteworthy from the fact that it almost everywhere contains pyroxene.

The district is much faulted, large faults bound it on the east and west, a somewhat complicated system of faults approximately parallel to these bounding faults intersects it, and there are other dislocations of importance.

REVIEWS.

I.—Life and Letters of Peter and Susan Lesley. Edited by their daughter, Mary Lesley Ames. 2 vols. 8vo : pp. xii, 526, and v, 562, with 16 portraits, 17 sketch illustrations, and geological map. New York and London : The Knickerbocker Press (G. P. Putnam's Sons), 1909.

PETER LESLEY, the fourth in succession of that name, was born in Philadelphia on September 17, 1819, and died at Milton, near Boston, on June 1, 1903, in his 84th year. His great-grandfather belonged to Scotland, and was known as the "Miller of Fifeshire". His grandfather (Peter the second) settled in Boston, U.S.A., as a cabinet-maker, and his father (Peter the third) succeeded to this business. Peter the fourth, however, did not like his Christian name, and while during his father's lifetime he signed his name "Peter Lesley, Jr.", he subsequently transferred the J to the front, and became J. P. Lesley, in which form his name has been familiar to geologists.

In an interesting and appreciative obituary memoir, which formed part of the anniversary address delivered by Sir Archibald Geikie as Vice-President of the Geological Society in 1904, J. P. Lesley was described as "one of the most distinguished and lovable men of science in the United States"; and in the two volumes before us ample testimony is given of the justice of those words.

In early years Lesley received from his father, who was a man of high principle and wide culture, a valuable training in mechanics, in perspective and machine drawing; he was sent to the best schools,

acquired a knowledge of Latin, Greek, French, and German, and in 1838 graduated in the University of Pennsylvania. It was his intention to enter the ministry, and to complete his studies in divinity at Princeton. His health, however, gave cause for anxiety, and it was suggested that he should take a season of outdoor work on the geological survey that had been established in 1836 under the direction of Henry D. Rogers. Lesley was well qualified to start as a surveyor and draughtsman. Thus it came to pass that, in 1839, he was appointed a sub-assistant on the First Geological Survey of Pennsylvania, and his very diversified career commenced from that date.

In her preface to the first volume, Mrs. Ames remarks—"I have not attempted to write of my father's scientific life, not being competent to do so; but in the Appendix will be found several of the obituary notices written by scientific friends, which will to some extent supply this omission." Lesley's claim to scientific distinction, apart from his Professorial work, rests on his able and original surveys of the coal regions of Pennsylvania; on the maps and reports which he prepared, first as assistant to Rogers, and finally as Director of the Second Geological Survey of the State; on his *Manual of Coal and its Topography*, his *Iron Manufacturers' Guide*, and other works and papers, of which a list is given.

Nevertheless, in the two volumes of biography we learn from letters and diaries a good deal of geological interest about Lesley, his methods of work, his many journeys to Europe, and of men of science he met; and we are impressed not only by his unflagging industry, interrupted though it was by periods of illness, but likewise by the happy home life and general interests of both Lesley and his wife. After serving about three years with Rogers he resigned his official appointment, and completed his theological training. He then laboured for the American Tract Society, became pastor of a Congregational Church, and finally was converted to Unitarianism. During this period of about ten years he was occasionally employed by Rogers in field-work and in preparing maps and sections for the Report of the First Geological Survey. After its publication in 1852 a coolness arose in the friendship between Rogers and Lesley owing to the unfortunate omission on the part of the Director to acknowledge adequately the large share of work performed by his various assistants. Mrs. Ames remarks—"Very possibly this fact was not due to an ungenerous intention, but to the theory that, since the responsibility of a survey rested on the head of that survey, to him also was due the credit of the work done." Lesley put the matter right in a subsequent publication, and Rogers never spoke to him again.

The records of his many journeys to this country and various parts of Europe, also to Egypt, are full of interesting observations and reminiscences. In his first journey in 1844 he met Elie de Beaumont and von Buch, and on subsequent expeditions he saw much of Desor, whose acquaintance he made in America in 1851, and whose genial company, as he remarked, was "enough to keep a dozen men in humour". Later on, at Desor's chalet at Combe Varin, near Neuchâtel, he had many "jolly times"; and it is mentioned that the road leading

to the house was bordered by tall trees of various kinds on which names of distinguished visitors were from time to time inscribed.[1]

We read of Barrande, who in 1851 had "been able to throw 20 species and 12 genera into *one*", and wish that such a process could be continued; and we find many memoranda about Lesquereux, the distinguished botanist. He was son of a watchmaker at Neuchâtel, and early in his career was professor in the University of Stuttgart, but becoming stone-deaf he had to abandon his post, and his health was for a time broken. It is touching to learn that his wife "laid aside all the prejudices of her early education, and with astonishing perseverance learned a branch of the watch-making trade, and supported her husband and five children for nearly three years". Lesquereux recovered his health, but not his hearing, and settled for the sake of his family in the United States, where he became renowned for his researches on fossil plants.

An interesting account is given by Lesley of a dinner with the Royal Society Club in 1863, in which year also he met Dr. Percy, who "was waiting for me in his study, and at once made me at home with cheroots and a glass of sherry". They had much to discuss concerning iron-ores.

He saw the *Archæopteryx* from Solenhofen with Owen, who thought that the remains included "the front jaws of some fish which the bird has eaten".

There are reminiscences also of Sir Henry Holland, of Ramsay, and Sir William Hooker, as well as of a visit to Lyell when he had a children's party in 1863, and there were present Leonard Horner, Darwin, and Bishop Colenso.

Lesley dined with the Geological Society Club in 1864, meeting Murchison, Lyell, Lord Enniskillen, Ramsay, and others; but it is noted that W. J. Hamilton was "perpetual Secretary" and Smyth "Clerk", whereas both were Secretaries for the time being.[2]

Again, we find Lesley at the International Geological Congress in Paris in 1878, and he mentions that at one meeting when Hébert presided, "Everybody talked all at once. Three sometimes spoke vehemently without listening to each other. Total absence of parliamentary rules." There are reminiscences also of meetings with Gosselet, Heim, Barrois, and others.

During many years Lesley was very fully occupied in making reports for companies and private individuals on coal, iron-ore, and petroleum. In 1872 he was appointed to the Chair of Geology in the School of Mines at the University of Pennsylvania, and in 1874 he became State Geologist. Of his great work in connexion with the Second Pennsylvanian Survey, Mr. J. J. Stevenson has remarked—"He was

[1] It is to be regretted that no obituary notice of Desor appeared either in the Quarterly Journal of the Geological Society or in the Geological Magazine.

[2] We have noticed few other mistakes; but in vol. i, on p. 244, the "Dean of York" should be Dean of Westminster (Buckland), on p. 445 "Leyme" should be Swanage, on p. 446 "Riggs" should be Trenham Reeks, and in vol. ii on p. 74 "Hapley" should be Huxley. Mrs. Ames was evidently in doubt about some of these names, owing to difficulty in reading the MS.; but her work bears evidence of scrupulous care.

head rather than director. An assistant once appointed was left practically to his own devices; but there was something about the personality of the director that impelled each one to do faithful work, that made the unambitious man ambitious." Lesley did all he could to encourage his men to work well and accurately, and spared no pains to make the published maps and reports worthy of the State. It was observed by one of his assistants, Dr. H. M. Chance, that "probably no public organization was ever less bound by the red-tape of officialism".

More than 120 volumes of Survey Reports passed through Lesley's hands, and eventually he undertook a "Final Summary Report", publishing two volumes and preparing a portion of the third and last volume, embracing in all more than 1800 octavo pages; but failing strength forbade the completion of the concluding chapters, the writing of which was delegated to others.

In an autobiographical letter written by Lesley to a friend in February, 1882, he modestly remarks—"The only original ideas in geology for which I could venture to claim credit are, (1) the determinations of the present system of surface drainage by the dimpled form of the plicated original surface; and (2) the production of all modern topography chiefly by the underground dissolution of limestone strata, of all ages." These remarks, which we presume were based on his Pennsylvanian work, will be of interest to those who in recent years have given attention to the subject.

The very ample record which Mrs. Ames has given in these two volumes is sufficiently varied to attract many readers interested in art, theology, and politics, as well as science. There are memoranda relating to the Civil War and other momentous matters; but the chief interest is the biographical study of two high-minded individuals. While it is pleasant to read of Lesley's "intense interest in his profession, his real love of and satisfaction in hard work, his delight in nature", it is pleasant also to read of his charming helpmate, and of the closing tranquil years which they spent together in their country home at Milton.

H. B. W.

II.—What is a Mineral?

THIS question forms the title of an interesting essay by Professor J. W. Gregory (Trans. Inst. Mining Eng., read February 10, 1909). The subject is one that has for many years proved attractive to lawyers and scientific witnesses; it was referred to in the Geological Magazine for December last (p. 564) under the heading "Is China Clay a Mineral?" and it is of special concern in connexion with the present Parliamentary Budget and the question of "ungotten minerals".

Professor Gregory has entered very fully into the definitions given by various authorities, and shows that all the explanations of what is meant by a mineral fail from a scientific point of view, whether we speak of simple minerals or mineral species as distinguished from rocks. Thus physical properties, chemical composition, and crystalline

structure cannot be relied upon when we consider opal, serpentine, and wad, the felspars, apatite, and tourmaline, as in geometric form or composition they afford no support to precise definitions.

The question of most importance at the present day is what is a mineral from the commercial point of view. In regard to mineral rights, "coal, ironstone, slate, or other minerals" are usually specified in legal documents, and, as Professor Gregory remarks, none of these are really mineral species. In official publications, in the Mining Statistics formerly issued by the Geological Survey (see pt. ii for 1858), various clays, as well as chalk, building-stones, sand, etc., were included under "Earthy Minerals"; and in the present reports issued by the Mining Inspectors of the Home Office practically everything mined or quarried is included under the heading of "Mineral Products".

The result is that every geological formation, and practically the whole of the British Islands, might be considered to contain "ungotten minerals" at a greater or less depth. A common-sense list of all such minerals seems impossible, and therefore in the case of legal documents it would seem necessary in future to specify every mineral of which the right of working was reserved, and to omit the vague reference to "other minerals". In the new Parliamentary Budget (as it stands at present) sand, gravel, chalk, and common brick-clay are to be exempted from duty. As remarked by Professor H. Louis, it is possible that common clay may some day be utilized as a source of aluminium; moreover, in some places it may be difficult to separate "common brick-clay" from terra-cotta clay, or other clay that may be put to special use. Seams of coal that cannot now be worked with profit may be mined in the course of time.

Professor Gregory concludes that "A mineral of commercial value may be defined as a constituent of the earth's crust which, if organic in origin, has been altered by fossilization, and which has a value of its own apart from its value as a soil or as a support"; and that the question "when a surface-material acquires such economic value that it should be included in the category of commercial minerals must be determined for each case as it arises, but should occasion no serious difficulty".

III.—The Seventy-fifth Anniversary of the Mining Journal.

THE *Mining Journal*, which claims to be "the oldest Mining Paper and the Pioneer of the Technical and Trade Press of the World", has issued a seventy-fifth Anniversary Number, August, 1909. We take it that it is the oldest existing paper devoted to the subject, inasmuch as it absorbed at an early date *The Mining Review*, which had before been published quarterly. The career of the present journal coincides practically with the history of modern mining. The opinion is expressed that "the mining output of the past ten years is equal to that of the whole previous history of the world". Coal, iron, copper, zinc, and gold, as well as manganese, aluminium, nickel, oil, nitrates, and phosphates, are included in the estimate.

Some unfavourable comparisons are made between the economic work done by the United States Geological Survey and by that of Great Britain, "so far as regards metalliferous work at any rate"; but since the time of De la Beche a good deal of economic work has been done by the Survey in this country, notably on iron-ores, and more recently on the metalliferous regions of West Cornwall, while many memoirs relating to coal and coal-measures, water-supply, building-stones, etc., have been published. In fact as much has been done as possible with the meagre financial support accorded to the Geological Surveys in Britain.

The present anniversary number of *The Mining Journal* contains, in addition to sundry trade reports, particulars of mining in various parts of the world, together with interesting articles on "Mining Engineers Past and Present", by J. D. Kendall; on the "History of Mining in Australia", by F. D. Johnson; and the "History of Mining in New Zealand", by Professor James Park.

IV.—The Battle of Land and Sea on the Lancashire, Cheshire, and North Wales Coasts, with special reference to the origin of the Lancashire Sandhills. By William Ashton. Second edition. 8vo; pp. vi, 217. Southport: William Ashton and Sons, 1909. Price 1*s.* 6*d.* net.

THE first edition of this work was issued in May of the present year, and the second edition, revised and with additions, in July. It has had the advantage of following the Report of the Royal Commission on Coast Erosion (1907), and the author acknowledges help received from T. Mellard Reade and Joseph Lomas, whose deaths we have had so recently to deplore. Mr. Ashton gives full particulars of the losses of land and other changes along the north-western coasts, and has illustrated his subject with numerous maps. Cheshire has suffered more by coast erosion than other counties dealt with. The author maintains that the chief source of the Lancashire sand-dunes is the river-borne sedimentary matter brought from the Millstone Grit of the Pennine Range, and he was supported in this view by microscopic examinations of the sands made by Lomas. An index would have added greatly to the usefulness of this little book, which bears evidence of much painstaking research.

V.—Brief Notices.

1. A Century of Geological Maps of New York.—Mr. Henry Leighton has written an article on "One Hundred Years of New York State Geologic Maps, 1809–1909" (reprinted from the Fifth Report of the Director for 1908, New York State Museum Bulletin No. 133, 1909). A list of 329 maps, with index, is given, commencing with McClure's map of the United States coloured geologically in 1809. The first independent geological map of the State was that of Amos Eaton, 1830, of which a colour-printed copy is inserted.

2. Geology of the Country around Londonderry.—We have omitted to notice that the Geological Survey of Ireland, under the Department

of Agriculture and Technical Instruction, issued in 1908 a special colour-printed map and memoir of the geology of the country around Londonderry, the work of Messrs. S. B. Wilkinson, A. McHenry, J. R. Kilroe, and H. J. Seymour, under the direction of Professor G. A. J. Cole. In mapping the Drifts it was found necessary also to map (on the six-inch scale) the Igneous, Metamorphic, and Lower Carboniferous rocks. The memoir is well illustrated with photographic plates and text-figures, and contains much of scientific interest as well as accounts of soils, water-supply, and other economic matters.

3. The Queensland Geological Survey has issued a second report on "The Etheridge Goldfield", by Mr. W. E. Cameron (publication No. 219, 1909). This goldfield occupies an area of more than 13,000 square miles, the centre of the field being about 200 miles south-west of Cairns. The rocks consist of granite, quartz-porphyry, and diorite, together with altered sedimentary rocks, comprising massive white quartzites, schists, and slates, with which are associated numerous mineral veins carrying gold, silver, lead, and copper. The gold-bearing quartz veins occur, however, mainly in the granite, and the yearly average yield of reef gold since 1900 has been 9000 ounces.

4. Permian Footprints.—In an essay on "British Permian Footprints" (Mem. Manchester Lit. and Phil. Soc., 1909, liii), Mr. George Hickling endeavours to show that footprints may be used to distinguish Permian from Triassic deposits. Judging by the footprints from definite Permian strata at Mansfield and Penrith, he would group the footprint-bearing rocks of Corncockle Muir and other localities in Dumfriesshire, and those of Cummingstone in Elgin, as Permian.

5. Erosive Action of Snowfall.—In an essay entitled "Physiographical Notes, No. 1" (*Geographical Journal*, July, 1909), Mr. G. W. Lamplugh discusses the erosive conditions resulting from snowfall. He has been impressed by the great discrepancy between the effects of erosion on contiguous tracts in various parts of Ireland and in the north of England, where drumlins of boulder-clay, esher-ridges and kame-mounds of sand and gravel, and moraines of incoherent rubble, show little or no evidence of subærial denudation, while neighbouring streams have cut trenches through a great thickness of drift into the underlying bed-rock. In explanation he has been led to conclude that there was much winter precipitation of snow during the waning phases of the Glacial epoch, and that during the warmer season the gradual melting of the snow caused a gentle flow of water over the slopes, but led to powerful torrential action along the stream-channels. This explanation is well worthy of consideration, apart from other evidence that would apply in some localities, of erosion due to flood-waters resulting from the melting of ice in earlier times, or of the re-excavation of ancient buried channels.

6. Dew-Ponds.—Mr. E. A. Martin has further dealt with the subject of Dew-Ponds (*Geographical Journal*, August, 1909), and gives some analyses of the waters. The presence of sodium chloride is interesting as an indication that much of the aqueous vapour came from the sea. In the course of discussion Dr. H. R. Mill referred to

the ponds on Mill Hill and the high ground of Totteridge, which have a very restricted drainage-area, and must owe their replenishment to the same cause as the dew-ponds of the South Downs.

7. Land Forms.—Another important communication, bearing on Geology and Geography has been brought before the Geographical Society by Professor W. M. Davis (*Geographical Journal*, September, 1909). He has, in a discourse on "The Systematic Description of Land Forms", sought to persuade geographers to introduce concise methods of description and to employ precise terms for types of feature. For this purpose a knowledge of geological structure as well as the forces of erosion is necessary.

8. A New Jurassic Ammonite.—A description of a new species of Ammonite, of the genus *Stephenoceras*, was contributed by the late Dr. J. F. Whiteaves to *The Ottawa Naturalist* (May, 1909). The specimen was obtained from rocks, presumably of Jurassic age, in the Nicola Valley, British Columbia.

9. Tin Deposits in the Malay Peninsula.—In a paper on "The Origin of Tin Deposits", read by Mr. J. B. Scrivenor, before the Perak Chamber of Mines, 1909, the author concluded that the tin deposits in the Malay Peninsula conform with tin deposits elsewhere in having as their source a mass of igneous rock containing a high percentage of silica. The importance of fluorine as a reagent in the processes that led to the formation of cassiterite was emphasized, while, on the other hand, it appeared that boron was not essential in those reactions.

10. Tin Mining and Water Supply, Federated Malay States.—We have received the Annual Report for 1908, of Mr. Scrivenor, Geologist to the Federated Malay States. He deals with the question of water supply, and with the expectation that at a depth beneath the alluvial mangrove mud of the Perak River there might be found sand saturated by springs from the bed-rock of the valley. A trial-bore at Bagan Datoh has, however, encountered brackish water at a depth of 150 feet. The tin-mining receives special attention, and the Lahat 'pipe' is described as an instance of a lode-deposit which is being converted *in situ* into a detrital-deposit. The alluvial ore-deposits are likewise dealt with.

CORRESPONDENCE.

ON THE USE OF THE TERM 'LATERITE'.

Sir,—In the September number of the Geological Magazine, p. 431, Mr. J. B. Scrivenor has written objecting to the restricted and definite use of the term laterite as advocated in the *Bulletin of the Imperial Institute*, 1909, vol. vii, p. 134. Mr. Scrivenor claims that the word laterite "has been used in the Malay Peninsula for many years by a large body of engineers for what are essentially masses of iron oxide replacing portions of weathered rocks, and filling fissures in such rocks near the surface". He also claims that "laterite is an engineer's rather than a geologist's term, covering rocks of varying

composition". The word has, however, been consistently used as a scientific term, and its meaning, at least so far as geologists are concerned, should be decided not by the loose usages of engineers, but by the way in which it was first defined and subsequently used by the best authorities.

The term laterite was introduced in 1807 by F. Buchanan in his *Journey from Madras, through Mysore, Canara, and Malabar*. He describes the occurrence of iron ore at Angadapuram in the hills west of Calicut on the Malabar coast, and in vol. ii, p. 436, remarks as follows:—"In all the hills of the country the ore is found forming beds, veins, or detached masses in the stratum of indurated clay, that is to be afterwards described, and of which the greater part of the hills of Malabar consists."

It will be seen that Buchanan clearly regarded the indurated clay as distinct from the iron ores. On p. 440 he continues: "What I have called indurated clay . . . is one of the most valuable materials for building. It is diffused in immense masses, without any appearance of stratification, and is placed over the granite which forms the basis of Malayala. It is full of cavities and pores and contains a very large quantity of iron in the form of red and yellow ochres. In the mass, while excluded from the air, it is so soft, that any iron instrument readily cuts it, and is dug up in square masses with a pickaxe, and immediately cut into the shape wanted with a trowel, or large knife. It very soon after becomes as hard as a brick, and resists the air and water much better than any bricks I have seen in India. . . . As it is usually cut into the form of bricks for building, in several of the native dialects it is called the brick stone (*Itica cullu*). . . . The most proper English name would be Laterite, from Lateritis, the appellation that may be given to it in science."

The laterite thus described by Buchanan is the clay-like material which occurs extensively in India as the product of one type of tropical or subtropical weathering of crystalline rocks, containing aluminous silicates, and which is essentially characterized by the presence of hydrated alumina. It has, as Buchanan says, the power of hardening on exposure, and for that reason it has been extensively used as road metal. It is to this material that the word laterite has been for many years mainly applied in India, not only by geologists, but also by engineers.

The recognition of the fact that laterite is essentially characterized by the presence of free hydrated alumina is due to Professor Max Bauer, who worked on the laterite of the Seychelles (*Jahrbuch für Min.*, etc., 1898, vol. ii, pp. 192–219).

The conclusions arrived at by Max Bauer were confirmed and amplified by Sir Thomas Holland, late Director of the Geological Survey of India, in a paper "On the Constitution and Dehydration of Laterite", published in this Magazine (Decade IV, Vol. X, 1903, p. 59), and have been almost universally adopted among Continental geologists.

We find, therefore, that Buchanan, who introduced the term laterite, attached to it a significance which is in strict agreement with modern

scientific usage; and the loose application of the term to ordinary ferruginous clays, iron ores, etc., is wholly unwarranted.

From a scientific standpoint, Mr. Scrivenor's suggestion that the term bauxite should be applied to laterite in the sense here defined is not justifiable. Bauxite is a mineral name, signifying a hydrated alumina of fairly definite composition. Laterite is properly a rock name, signifying the product of a special kind of weathering; it is a complex product, essentially characterized by the presence of free hydrated alumina, but usually containing also notable amounts of titanium and iron oxides, whilst free silica is generally present, and hydrated silicate of aluminium is not necessarily absent. The amount of iron oxide is very variable; but when it becomes excessive it usually separates out in the form of concretionary iron ore. In defining the word laterite, however, Buchanan, as we have already seen, clearly distinguished such iron ore from the laterite in which it occurred; and in no case did he apply the term to material resembling that referred to by Mr. Scrivenor as "masses of iron ore".

The term laterite is used in a loose way not merely for material which is essentially iron ore and which should be described as such; it is also used by some people as a name for any ferruginous clay, sand, or gravel which may occur at or near the surface in tropical and subtropical countries. Such uses of the term are unscientific, and cannot properly be adopted by geologists, any more than they can adopt the engineers' use of the term granite to cover all holocrystalline igneous rocks, including syenite, diorite, and gabbro.

T. Crook.

Imperial Institute,
London, S.W.

"AN EGYPTIAN OASIS."

Sir,—In your review of this work (p. 477) you call special attention to Mr. Beadnell's suggestion, that a lake in the Kharga district may have been due to the letting loose of artesian waters through denudation of the once overlying impervious beds. This interested me much, as I had attributed to the same cause the formation of swallow-holes and valleys. (See "Ightham", Homeland Association, 1907, pp. 127–30, and also more fully in *Geographical Journal*, September, 1908.) It is, therefore, gratifying to have my views independently confirmed by one who has had such intimate experience of flowing artesian wells as Mr. Beadnell.[1]

I may say that before my views were published I put them forth in correspondence with some leading geologists, and they were strongly contested by some and not really accepted by any. Those who attended the Loose Valley Excursion this year of the Geologists' Association in July saw an area near Maidstone where, as I consider, this suggested method of valley formation is particularly well shown.

F. J. Bennett.

West Malling.
October 7, 1909.

[1] See also Capt. H. G. Lyons, Quart. Journ. Geol. Soc., 1894, vol. l. p. 541.

OBITUARY.

DR. FELIX ANTON DOHRN,

For. Memb. R. S.

Born December 29, 1840. Died September 26, 1909.

It is with deep regret we have to record the death of an old and valued friend and fellow-worker, Dr. Anton Dohrn, Founder and Director of the famous Zoological Station at Naples, an institution for the study of marine organisms, the existence and maintenance of which were largely due to his genius and energy, and upon which he must have expended a considerable amount of his own private means. Born at Stettin in 1840, son of the well-known entomologist Carl August Dohrn, and brother of Dr. Heinrich Dohrn, who devoted himself to the study of malacology, Anton Dohrn was educated at Königsberg, Bonn, Jena, and Berlin, and paid especial attention to invertebrate zoology, having at the age of 27 established himself as a private teacher of zoology at Jena.

As early as 1858–60 Anton Dohrn had published various short treatises on the Hemiptera, and took his degree as a Doctor in science in 1865 by a work on the anatomy of foreign Hemiptera, published in 1866–8. During his residence at Jena, Dr. Anton Dohrn also paid considerable attention to fossil insects, and published important papers on them and upon other Arthropoda, particularly on the development of *Limulus polyphemus*, etc.—

"*Eugereon boekingi*, eine neue Insectenform aus dem Todtliegenden" (*Palæontographica*, vol. xiii, pp. 333–40, Taf.), 4to, Cassel, 1866.

"*Eugereon boekingi* und die Genealogie der Arthropoden" (*Stett. entom. Zeit.*, Bd. xxviii, pp. 145–53, pl. i [xli]), 8vo, Stettin, 1867.

"Zur Kentniss der Insecten in den Primarformationen" (*Palæontographica*, vol. xvi, pp. 129–34, Taf. viii), 4to, Cassel, 1867.

"Die embryonale Entwickelung des *Asellus aquaticus*" (*Zeitschr. Wissensch. Zool.*, xvii, 1867, xvii, pp. 221–77).

"Zur Embryologie und Morphologie des *Limulus polyphemus*" (*Jenaischen Zeitschrift*, Bd. vi, Heft iv, p. 639), Jena, 1871.

In 1870 he visited Naples and shortly afterwards founded the Zoological Station, in which he received the aid of the leading zoologists in Germany and England, and later the powerful support of the then Crown Prince of Germany, the Berlin Academy of Sciences, the British Association, and afterwards by the German Government itself. The lasting services rendered to Biological Science by Dohrn through the establishment of the Naples Zoological Station are well known. He dedicated all the best energies of his life to this work, and had in these last years been energetically supported by the German Emperor.

As the Zoological Station became more and more widely known, and the work carried on as a research laboratory for biological students better understood, the greater became the number of visitors, and the institution received considerable support from American as well as from European Universities and men of science.

In 1875 Dr. Dohrn published a work *On the Origin of Vertebrate Animals* and *On the Morphology of the Pantopoda of the Gulf of*

Naples. From 1881 to 1907 he published, in twenty-four parts, a primæval history of the Vertebrata (*Studien zur Urgeschichte des Wirbelthier Körpers*). Besides these he wrote various reports and essays on zoological stations, particularly upon that of Naples. The Royal Society's Catalogue gives the titles of fifty-nine papers by Dr. Dohrn up to 1883.

In addition to the valuable observations and records published by the Zoological Station at Naples, and the unrivalled opportunities afforded to students from colleges and universities, to whom tables for special work have been granted from time to time, the skilled scientific staff of the station have been engaged for years in the preparation and preservation of all the most delicate, difficult, and rare forms of invertebrata, such as the Coelenterata, the pelagic forms of Mollusca, Starfishes, and Crinoidea, the Jelly-fish, Corals, Sponges, etc.; these and an infinite number of other exquisite forms of marine life have been mounted and elaborately arranged, expanded as in life, in glass jars suitable for exhibition in museums. These are some of the services to science which for nearly forty years Dr. Dohrn and his staff have carried out at Naples Zoological Station.

Numerous honours were bestowed upon Dr. Dohrn, especially by the various Scientific Societies, of many of which he was made a foreign member. The city of Naples created him an Honorary Citizen. Honorary degrees of Doctor in Science and Laws were conferred upon him from Halle, Breslau, and Cambridge. Professor von Hildebrand had just executed a bas-relief portrait of Dr. Dohrn, which his friends had intended to present to him on his 70th birthday (December, 1910).

Dr. Dohrn's health had been in a very precarious state during the past year from heart trouble. He died at Munich on September 26, and was buried at Jena on October 3. The Emperor and many of the German Princes have sent personal messages of sympathy to Dr. Dohrn's family, who have also received numerous addresses from scientific bodies in all parts of the world. We are glad to learn that his son, Dr. Reinhard Dohrn, who has represented him there during the last two years, will succeed his father in the direction of the Zoological Station at Naples. Dr. Anton Dohrn's life has been one of strenuous labour, but we may say of him, now that he has concluded his life's work, *Palmam qui meruit ferat*.

[Partly supplied by Dr. Paul Mayer and in part by a translation from the Munich *Neueste Nachrichten*, September 30, 1909.]

MISCELLANEOUS.

Addendum.—In Mr. Donald MacAlister's paper, "Association of Cassiterite and Specular Iron in the lodes of Dartmoor" (see September number, 1909, pp. 402–9), on p. 406, to legend to text-illustration, "Fig. 3.—Microphotograph of Specular Iron-Tinstone from Birch Tor," *add* magnified 28 times.